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ATIKOKAN TGS POSTOPERATIONAL BIOLOGICAL STUDIES - 1986

Report No 88-225-K

G.T. Haymes and J.K. Kwik
Biological Research Section
Chemical Research Department

ABSTRACT

The first year of postoperational aquatic studies for Atikokan TGS was conducted during 1986. The depth of the thermocline in the first three lakes of the cooling circuit increased and the extent of hypolimnetic oxygen depletion in all lakes was reduced relative to previous study years. Stabilization of water levels may have resulted in increased distributions of macrophytes in Abie and Marmion Lakes while changes in sedimentation patterns as a result of station operation likely reduced the distribution of macrophytes in parts of Icy Lake. The catch of walleye and northern pike in gillnets was below that of previous years although this may be attributable to differences in the length of gillnet sets. The catch in beach seines of yellow perch in Snow and Icy Lakes increased substantially. Based on the results of drift netting and spawning observations the timing of walleye and white sucker spawning at the Snow Lake outlet may have been altered substantially due to operation of the station.

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EXECUTIVE SUMMARY

ATIKOKAN TGS POSTOPERATIONAL BIOLOGICAL STUDIES-1986

G.T. Haymes and J.K. Kwik
Biological Research Section
Chemical Research Department

Aquatic biological studies were conducted at Atikokan TGS during 1986. The objectives of the studies at Atikokan, initiated in 1981, are to identify changes in components of the aquatic environment as a result of station construction and operation. The studies were requested by Environmental Studies and Assessments Department. 1986 was the first full year of station operation.

The depth of the thermocline during the summer in the first three lakes in the cooling water circuit was greater than that observed prior to full station operation. Hypolimnetic oxygen depletion which was prevalent in all of the study lakes during the summer in previous years was much less acute in 1986. Higher oxygen concentrations in bottom waters were typical of all study lakes and consequently, the improved oxygen conditions cannot be attributed to the station. Nutrient concentrations in surface and bottom waters during 1986 were similar to or lower than previously reported values.

The density of submergent macrophytes in the northwest bay of Snow Lake increased between 1985 and 1986. This increase may have been related to the thermal discharge. However, the density had also increased between 1983 and 1985 in the absence of a thermal discharge suggesting that there may have been other factors responsible for the increased abundance observed in 1986. An increase in the distribution of macrophytes was observed in the special study areas in Abie and Marmion Lakes which may in part have been related to water level stabilization. The distribution in these locations had also increased between 1983 and 1985. The construction of weirs and dams had been completed by 1985 such that water levels had been stabilized. Currents in the connecting channels and outfalls may have been responsible for high sedimentation observed in the west and east bays of Icy Lake. Sedimentation in the east bay of Icy Lake resulted in the loss of submergent macrophytes in the eastern portion of the bay.

The catch per unit effort of northern pike and walleye in gillnets was below the range of previously reported values. This apparent reduction in pike and walleye, however, may, at least in part, be attributable to an increase in the length of gillnet sets from 2 to 24 hours at some locations. The composition of fish collected in beach seines, averaged over all locations was similar to previous years. At Snow and Icy Lakes, however, the contribution of yellow perch to

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the catch increased substantially.

Based on spawning observations, and collection of eggs and larvae in drift nets, it appears that the thermal discharge may have altered the chronology of spawning at the outlets of Snow and Ski Lakes into Icy Lake. During 1986, some walleye appeared to have spawned as much as a month earlier than in previous years at or upstream of the Snow Lake outlet. In addition, white suckers spawned prior to and simultaneously with some walleye at both the Ski and Snow Lake sites.

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To: Mr. C.W. Dawson
Section Head
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Design & Development - Generation

ATIKOKAN TGS POSTOPERATIONAL BIOLOGICAL STUDIES - 1986

1.0 INTRODUCTION

Atikokan Thermal Generating Station (TGS) consists of one 200 MW lignite-fired unit. The condenser-cooling-water for Atikokan TGS is drawn from approximately the 10-m depth of Moose Lake and discharged at the surface into Snow Lake. The discharge water circulates through Snow, Icy, Abie and Marmion Lakes before returning to Moose Lake (Figure 1-1).

At Ontario Hydro generating stations, aquatic studies are conducted for three years prior to commissioning of the first unit and for three years following commissioning of the final unit. Less intensive studies are also conducted during the commissioning of the station. The purpose of these studies, as requested by Environmental Studies and Assessments Department, is to identify changes in components of the aquatic environment which may be attributable to the construction or operation of the generating station.

Pre and postoperational aquatic studies at Atikokan TGS were initiated in 1981 and are scheduled to continue through 1988. Results of studies conducted since 1981 are presented in OHRD Report Nos 83-338-K, 84-54-K, 85-81-K, 85-333-K, 86-38-K and 87-233-K.

The study area consists of the five lakes of the cooling circuit; Snow, Icy, Abie, Marmion and Moose and two locations outside the direct influence of the cooling circuit, Slush Lake and Lower Seine Bay on Marmion Lake (Figure 1-1). The study lakes, particularly Marmion and Moose Lakes, have been altered substantially over the past 60 years due to industrial and mining activities in the area. Details of these perturbations are presented elsewhere (OHRD Report No 83-338-K).

The sampling locations employed in 1986 were similar to those of previous years. Ten sites were regularly sampled: one in each of Snow, Icy, Abie, Slush and Moose Lakes and in Marmion Lake at Marmion South, Central and North, Anderson Dam and Lower Seine Bay (Figure 1-1).

During 1986 the station generally produced power from 0600 h to 2200 h, five days a week with shutdowns on the weekend. Twenty-four hour operation was initiated during December. Non-weekend shutdowns were sporadic and rarely extended beyond 10 days with the exception of the period from June 18 to August 17 when the station was shutdown (Figure 1-2).

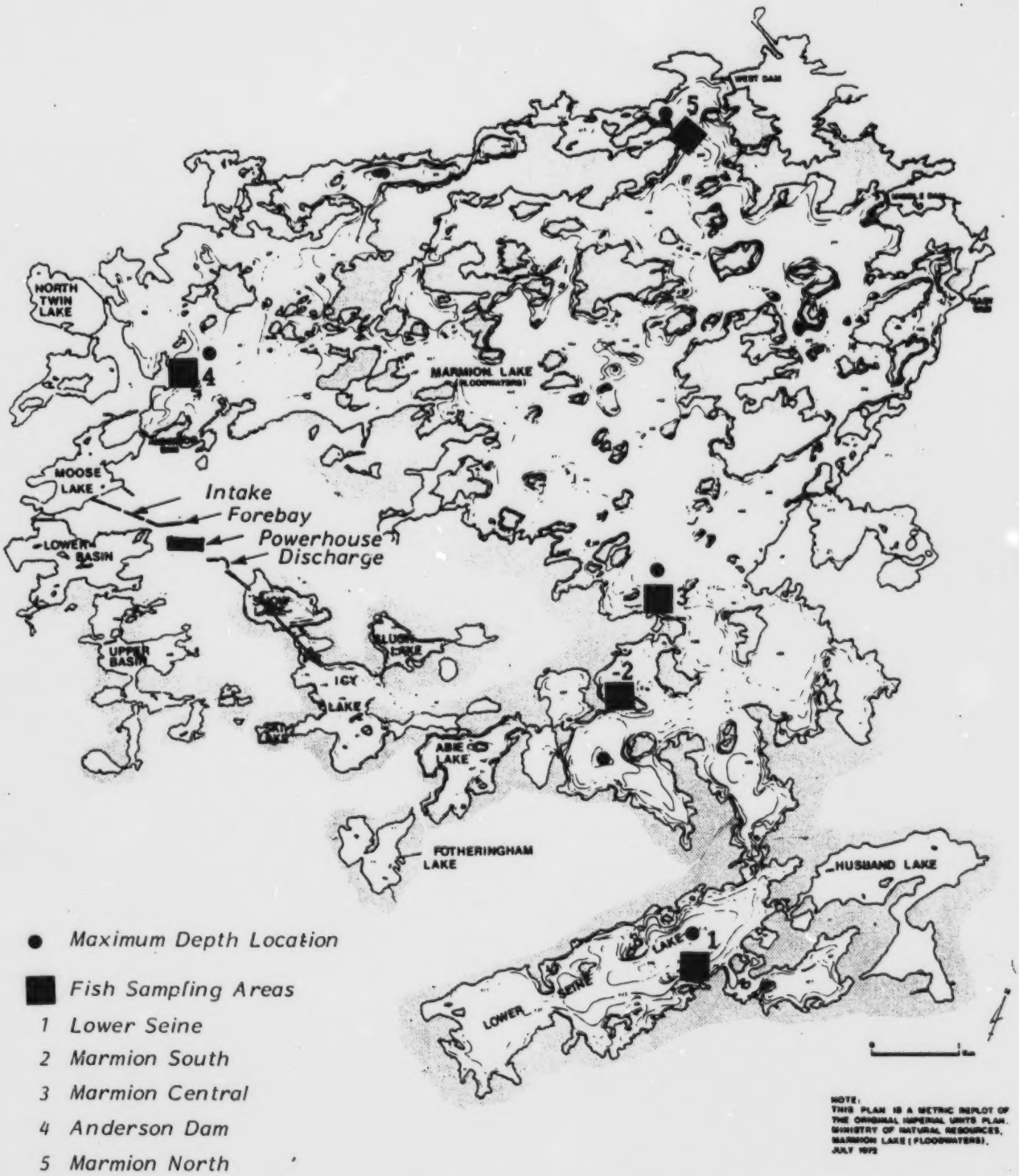

FIGURE 1-1

ATIKOKAN STUDY AREA AND
MARMION LAKE SAMPLING LOCATIONS

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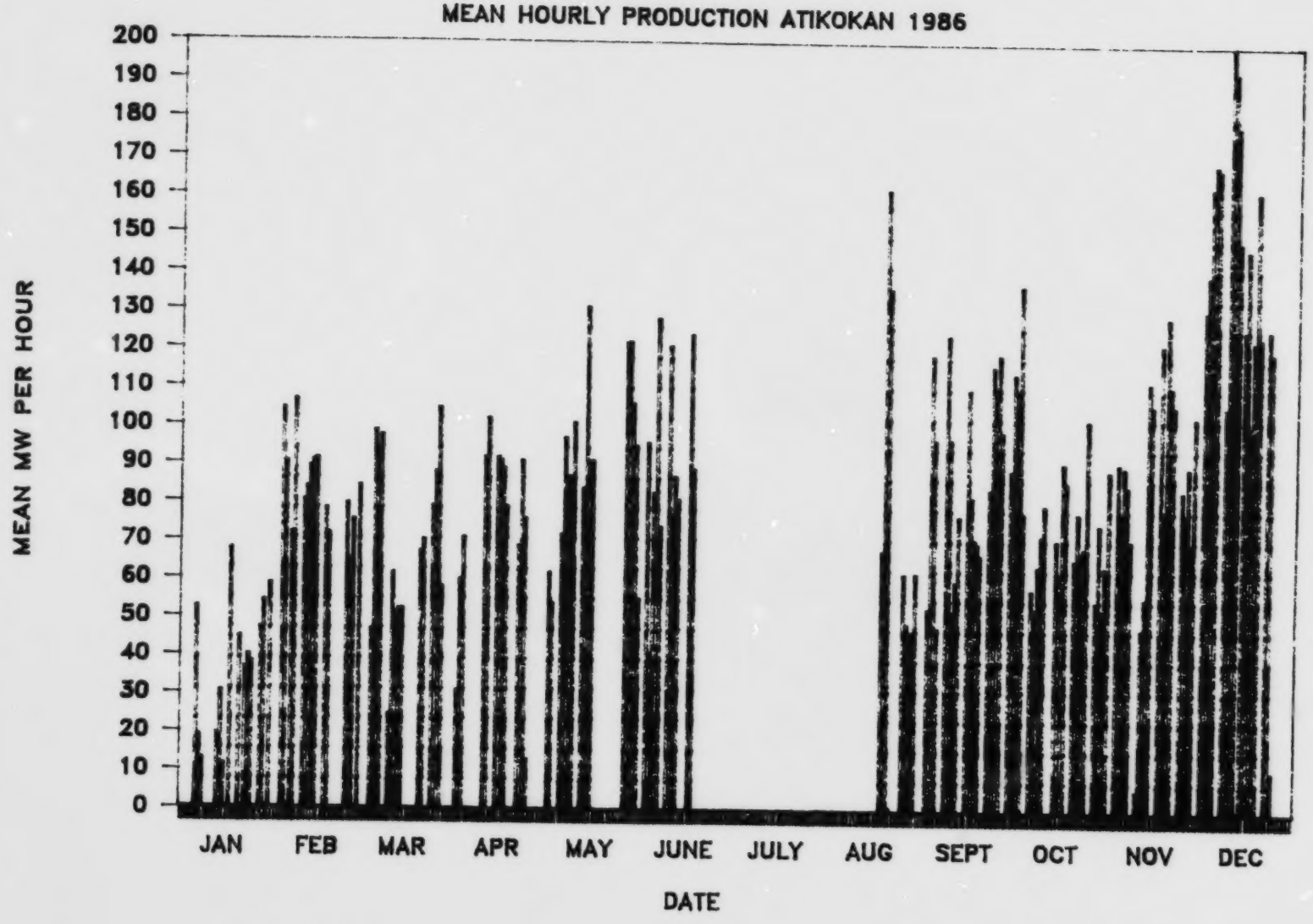
FIGURE 1–2


MEAN HOURLY PRODUCTION ATIKOKAN 1986
MEAN MW PER HOUR
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
DATE

2.0 METHODS AND MATERIALS

A sampling schedule for 1986 is listed in Table 2-1 and methods are described below.

TABLE 2-1

SAMPLING SCHEDULE ATIKOKAN 1986

	Apr	May	Jun	Jul	Aug	Sept	Oct
Temperature and Dissolved Oxygen	x	x	x	x	x	x	x
pH	x	x	x	x	x	x	x
Water Chemistry		x			x		x
Currents and Flows		x					
Macrophytes					x		
Gill Nets	x	xx	xx	x	x	xx	xx
Beach Seines		xx	xx	x	x	xx	xx
Larval Tows	x	xx	xx	x			
Drift Sampling (Plankton Nets)		x					
Drift Sampling (Tow Nets)	x	x	x	x			
Entrainment	x			x			

2.1 Temperature and Dissolved Oxygen

Temperature and dissolved oxygen profiles were taken at 1-m intervals in each of the 10 study basins once or twice per month from April through October. Measurements were taken with a Hydrolab 4000 meter. In addition, pH measurements were taken at the surface, mid-depth and bottom in association with the temperature and oxygen profiles.

2.2 Currents and Flows

Currents were measured at mid-depth at 1-m intervals across the connecting channels of the cooling water circuit during May. Measurements were made with a Marsh-McBirney flow meter. Flows were calculated using techniques described in Dodge et. al. (1980).

2.3 Water Chemistry

Surface and bottom water samples were collected in a Van Dorn bottle in each of May, August and October. The water samples were analyzed for major nutrients (total Kjeldahl nitrogen, nitrate, total phosphorus and soluble phosphorus) by the Analytical Chemistry Section.

2.4 Macrophytes

A survey of macrophyte composition and distribution was conducted in seven bays of the study area during August. The bays were previously surveyed in each year since 1982. Six of the bays were in the cooling circuit while the seventh was in Slush Lake (Figure 2.4-1).

The sampling methods and transects were the same as employed in previous years. Transects were cruised by observers in a boat or by a snorkeller who identified the species present and described the vegetational patterns. Voucher specimens of species which were difficult to identify were collected for later identification.

2.5 Fish

2.5.1 Gill Netting

Gill nets were set for a nominal 2-hr period in each of Snow, Icy, Abie, Slush and Moose Lakes and in Marmion Lake at Marmion South and Anderson Dam and for a 24-hr. period at Marmion Central, Marmion North and Lower Seine. Nets consisted of eight 15-m panels with stretched mesh sizes ranging from 3.8 cm to 12.7 cm in 1.3 cm increments and were set once in each of April, July and August and twice in May, June, September and October.

Meristics were taken on most northern pike, walleye, lake whitefish and cisco. Viable northern pike and walleye were tagged and released.

2.5.2 Beach Seines

Juvenile and forage fish were sampled by beach seine. Three hauls were made in each sampling basin on two occasions in each of May, June, September and October and once in July and August. All fish collected or, in the case of very large catches, sub-samples were returned to the laboratory for identification.

2.5.3 Larval Fish

Pelagic larval fish were collected in duplicate tows of 0.5 m larval tow nets in each of the study basins on 6 or 7 dates from late April to mid-July. The nets were towed for 5 minutes at a speed of approximately 1 m/sec sampling approximately 60 m^3 per net.

Three plankton nets were set for 24 hours in the outflow channels of Snow, Ski, Icy and Abie Lakes and at the outflow of Marmion Lake at Anderson Dam to collect eggs and larvae of fish spawning in the channels. These nets were set on five occasions during May. In addition, a 0.5 m larval tow net was set in the outflow of Snow Lake and of Marmion Lake at the Spillway Dam on five occasions from late April to mid-July.

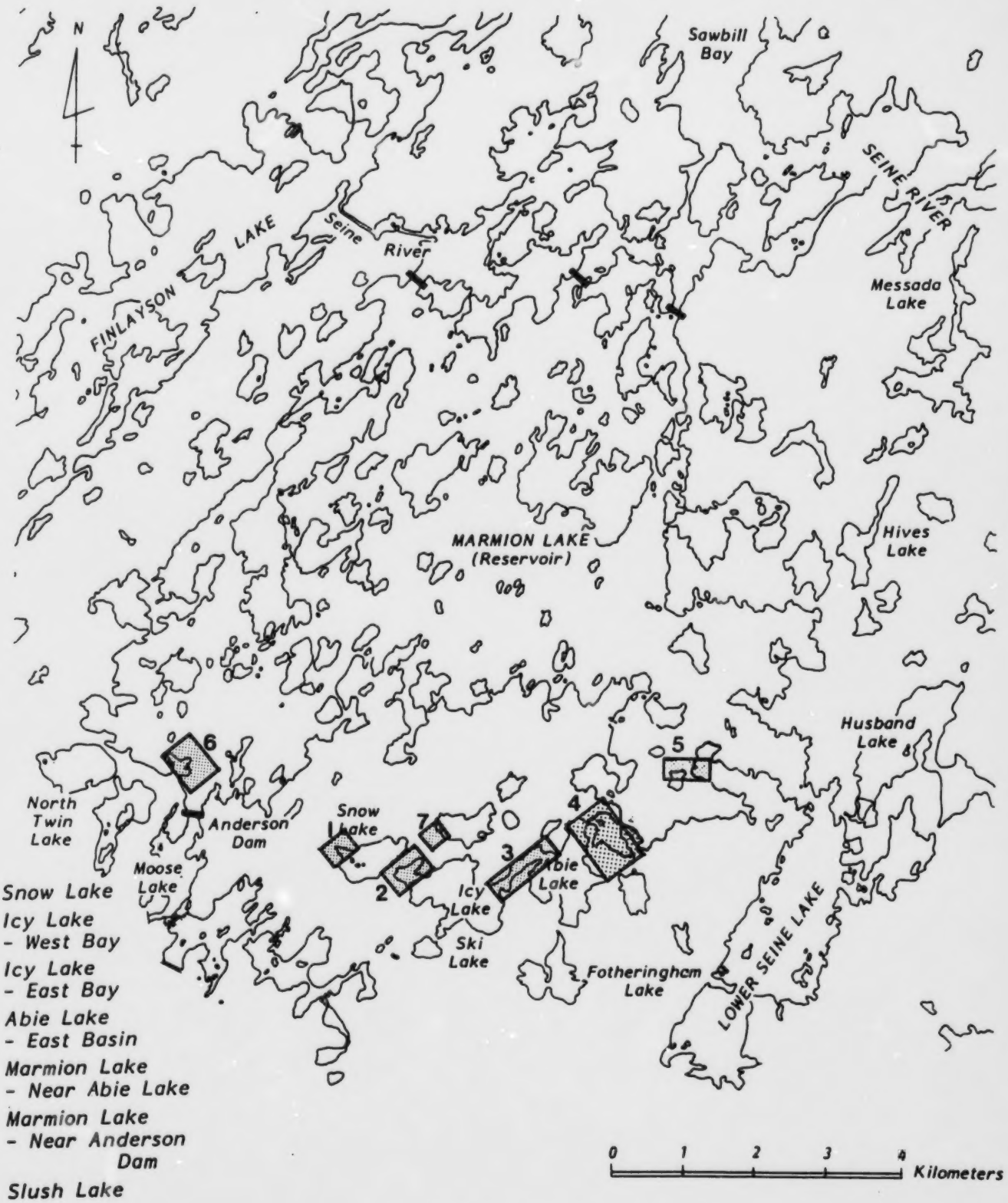


FIGURE 2.4-1

MACROPHYTE SAMPLING LOCATIONS

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The composition and abundance of icthyoplankton entering the station in the cooling water was sampled with larval tow nets set in the forebay. The nets were set for a total of 648 net hours between late April and mid-July, excluding the period from June 13 to July 12 when the CCW pumps were not operating. This period will be sampled during 1988. The nets were emptied after 6, 12, 18 or 24 hours of sampling.

All icthyoplankton samples were preserved in formalyn and retained for lab identification.

2.5.4 Walleye Spawning

Visits were made to the spawning grounds at the outflows of Snow and Ski Lakes after sunset from April 21 to 29 and on April 28 and 29 at the Spillway Dam on Marmion Lake. Observations of fish present in the outflows were made and walleye were collected for examination of spawning condition.

Attempts were made to collect and fertilize eggs for placement in incubation chambers to be deployed in the connecting channels of the cooling circuit. However, ripe males and females could not be collected together and this aspect of the study had to be abandoned.

3.0 PHYSICAL-CHEMICAL CHARACTERISTICS

3.1 Temperature and Dissolved Oxygen

Temperature and dissolved oxygen profiles are listed in Appendix 1 and presented graphically in Figures 3.1-1 to 3.1-3. During preoperational studies, the thermocline in the smaller, protected lakes (Snow, Icy, Abie and Slush) ranged in depth from 4 to 6 m, June through early September (OHRD Report No. 86-38-K). In 1986, however, the thermocline in Snow, Icy and Abie Lakes ranged from 5 to 9 m depth through the June to August period (Table 3.1-1). The depth of the thermocline in Slush Lake, unaffected by the discharge, ranged from 4 to 7 m. The apparent lowering of the thermocline and consequent increase in the volume of the epilimnion in Snow, Icy and Abie Lakes may be associated with greater mixing due to the currents established in the chain by the station's discharge but the CCW pumps were only operated intermittently from mid-June through mid-August when the station was not producing power. Information on the timing and extent of pumping during 1986 is not available.

The depth of the thermocline in Marmion Lake, 6 to 9 m, was similar to the 6 to 8 m noted during preoperational studies. In Moose Lake the thermocline was rapidly established at 14 m in May as a result of withdrawal of water by the station. This deep thermocline was also noted in 1985.

During the 1981-1985 period, hypolimnetic oxygen depletion was common during the late summer with measurements of 0 ppm very common. In 1986, however, no measurements of 0 ppm were made and measurements of reduced oxygen (2-4 ppm) were not measured or measured at deeper depths than in previous years (Table 3.1-2). As increased oxygen concentrations were typical of all sampling sites, changes in oxygen regime are not necessarily associated with station operation.

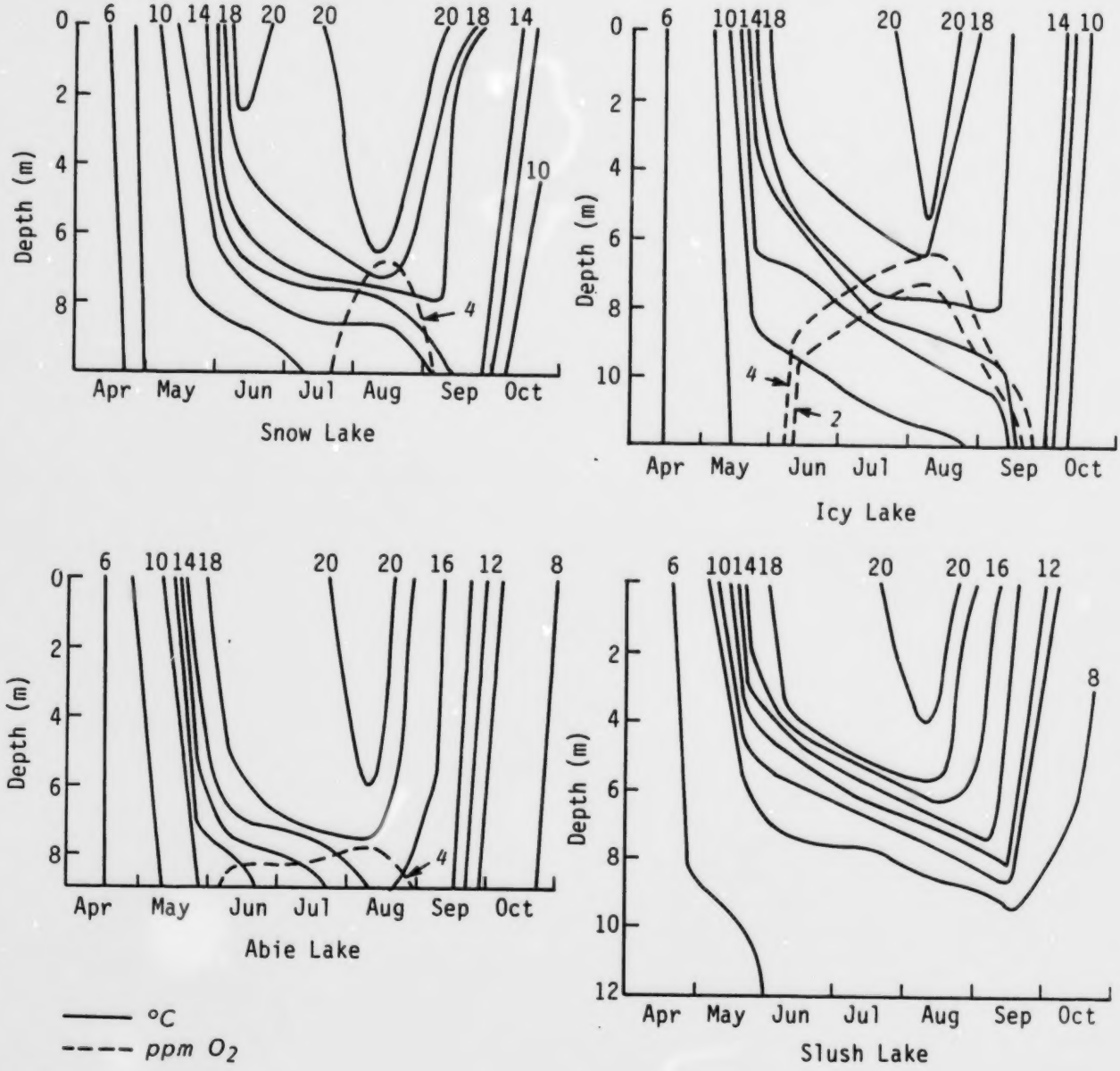

FIGURE 3.1-1

TEMPERATURE PROFILES AND AREAS OF OXYGEN DEPLETION IN SNOW, ICY, ABIE AND SLUSH LAKES - 1986

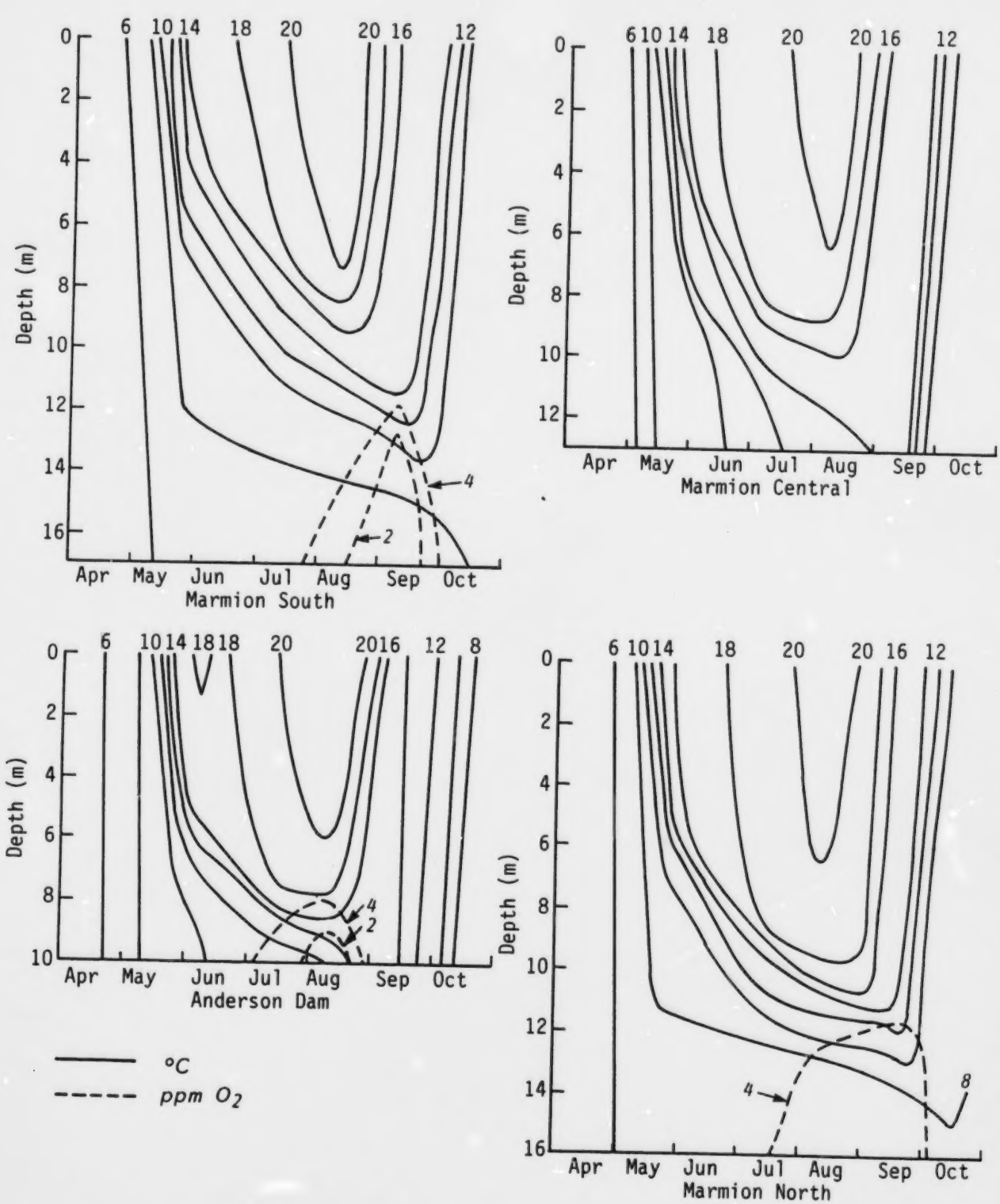

FIGURE 3.1-2

TEMPERATURE PROFILES AND AREAS OF OXYGEN DEPLETION IN MARMION LAKE - 1986

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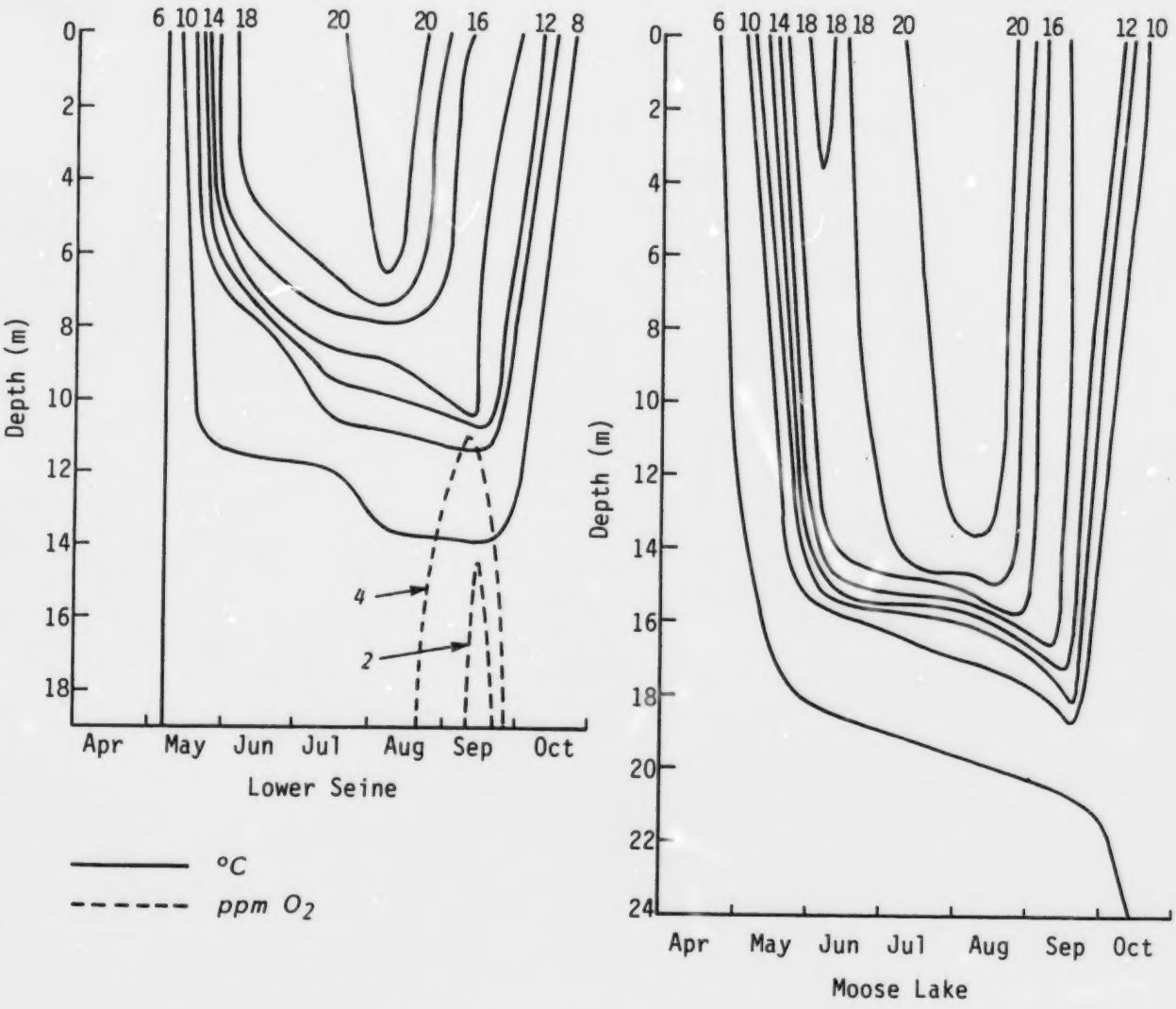


FIGURE 3.1-3
TEMPERATURE PROFILES AND AREAS OF OXYGEN DEPLETION AT LOWER SEINE AND MOOSE LAKE - 1986

TABLE 3.1-1

DEPTH (M) OF THE THERMOCLINE IN THE STUDY BASINS

Location	Apr	May	Jun	Jul	Aug	Sep	Oct
Snow Lake	-	-	5-7	8	8	-	-
Icy Lake	-	4	5-6	8	9	-	-
Abie Lake	-	6	7	8	8	-	-
Slush Lake	-	4	4-5	6	6-7	8-9	-
Marmion Lake South	-	-	6	8	9	13-14	-
Central	-	7	6-8	9	9	-	-
North	-	6	7-8	9	9	12-13	-
Anderson Dam	-	6	6	8	9	-	-
Lower Seine	-	5	6-7	8	8	11-12	-
Moose Lake	-	14	15	15	16	17-18	-

- no discernible thermocline

3.2 Water Movements in the Connecting Channels

Measurements of flows and currents were made in the major connecting channels of the cooling circuit during May. Flows from Ski Lake to Icy Lake decreased from 1.0 m^3 per second on May 7 to 0.6 m^3 per second on May 22 (Table 3.2-1), reflecting the diminishing freshet. The influence of the freshet was not discernible in the connecting channels of the cooling circuit, as the primary influence on flows was the operation of the condenser-cooling-water pumps. The flow rates at the outflows of Snow, Icy and Abie Lakes represent 100, 4 and 6 fold increases, respectively, from similar measurements in May, 1982 (OHRD Report No 84-54-K).

Average current measurements in each of the connecting channels were relatively similar throughout the month. However, variation among locations was substantial as the result of differences in depth and bottom topography. Similarly, variation in current velocity across each channel was a reflection of bottom topography.

TABLE 3.1-2

MINIMUM DEPTH (M) of 0, <2 AND <4 PPM OXYGEN ATIKOKAN 1986

Location	1986			Range 1981 - 1985		
	0	2	4	0	2	4
Snow Lake	*	*	7	5-8	5-8	4-7
Icy Lake	*	8	7	6-8	6-7	5-6
Abie Lake	*	*	8	7-9	6-7	5-6
Slush Lake	*	*	*	11-14	9-13	9-11
Marmion Lake S	*	13	12	10-*	9-14	7-9
Central	*	*	*	12-*	8-*	7-11
North	*	*	12	13	8-*	7-11
Anderson Dam	*	9	8	7-*	6-9	6-8
Lower Seine	*	15	11	13-*	8-16	7-15
Moose Lake	*	*	*	10-*	6-33	5-29

* - all measurements above level

TABLE 3.2-1

CURRENTS AND FLOWS IN CONNECTING CHANNELS, MAY 1986

Channel (From/To)	Date	Flow (m^3/s)	Current[1] Average (m/s)	Current[1] Range (m/s)
Snow L./Icy Lake	May 7	5.8	0.58	0.30-0.85
	May 14	8.2	0.66	0.31-0.90
	May 22	7.5	0.73	0.30-0.85
Ski L./Icy Lake	May 7	1.0	0.80	0.35-1.00
	May 14	0.7	0.64	0.40-0.75
	May 22	0.6	0.70	0.60-0.81
Icy L./Abie Lake	May 7	4.8	0.18	0.06-0.30
	May 14	5.8	0.20	0.09-0.28
	May 22	6.3	0.21	0.11-0.28
Abie L./Marmion L.	May 7	4.9	0.11	0.00-0.20
	May 14	4.6	0.12	0.02-0.22
	May 22	3.9	0.12	0.02-0.23
Marmion L./Moose L.	May 12	8.0	0.13	0.03-0.18
	May 22	8.8	0.14	0.08-0.19

[1]mid-depth measurements at 1-m intervals along a cross-section of the channel

Reduced pH values in bottom waters during the late spring, and summer period appeared to be related to thermal stratification and/or oxygen depletion.

3.3 Water Chemistry

3.3.1 Nutrients

Results of chemical analysis of surface and bottom water samples are listed in Table 3.3-1. On average, nutrient levels were generally lowest in Slush Lake and highest in one of the three small lakes of the cooling circuit. Differences, however, among all lakes, excluding Slush Lake, were small and inconsistent. The low values in Slush Lake are consistent with its oligotrophic nature.

A comparison of average nutrient levels in 1986 with those during the preoperational phase (Table 3.3-2) indicates that total phosphorus and nitrate concentrations in both surface and bottom samples were lower in 1986 than during 1981 to 83 at all locations. The higher nitrate values during the preoperational period were highly dependent on several samples in which nitrate levels were 2-orders of magnitude greater than those measured in 1986. In addition, analytical techniques used to determine nitrate differed between the two sets of samples. It is not known whether the large preoperational values are correct or are the result of an analytical or collection error. However, the 1986 values are similar to those reported for a number of remote lakes in the Atikokan area (Maki and Pugh 1984).

3.3.2 pH

Field pH measurements were taken in conjunction with temperature and oxygen profiles and are listed in Appendix 1. Observations of pH during 1986 tended to be higher at the surface and mid-depth than at the bottom during most of the sampling season (Table 3.3-3). Average pH measurements in surface waters were generally higher than those recorded during preoperational studies, while those from bottom waters tended to fall within the range of values observed from 1981 through 1983 (Table 3.3-4).

During 1986 pH measurements in surface waters generally exceeded neutrality throughout the sampling season while those in bottom waters were generally below 7.0 from May into September (Appendix 1). Several locations (Slush and Moose Lakes and Marmion South, Marmion North, Anderson Dam and Lower Seine) had pH values below 7.0 in late April which may indicate some localized acidic run-off during the spring freshet. Only Slush Lake had pH values below 7.0 during October. Isolated observations of relatively low pH (<6) were made in bottom waters of Slush and Moose Lakes.

4.0 BIOLOGICAL CHARACTERISTICS

4.1 Macrophytes

4.1.1 Species Composition

A list of species and the lakes in which they were found is presented in Table 4.1-1. The species lists for Icy, Abie and Marmion Lakes are based on surveys conducted along transects in areas selected for detailed study. The species lists for Snow and Slush lake are based on whole lake surveys. A total of 32 macrophytes and one charophyte (macrophytic algae) were identified in the 1986 survey. Lists of species found along transects in the special study areas are presented in Appendix 2. The scientific and common names of the macrophytes are listed in Appendix 3.

The three types of aquatic plant communities (emergent, floating-leafed and submergent) considered typical of temperate lakes were present in the study lakes. The growth forms of the

TABLE 3.3-1

NUTRIENT MEASUREMENTS IN SURFACE AND BOTTOM SAMPLES ATIKOKAN 1986

	Snow L		Icy L		Abie L.		Slush L.		Marmion S.		Marmion N.		Anderson Dam		Moose L.	
May	S[3]	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
TKN[1]	0.38	0.38	0.49	0.38	0.31	0.37	0.27	0.35	0.42	0.38	0.38	0.51	0.36	0.46	0.41	0.27
NO_3[1]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total P[2]	*	12.0	8.0	16.0	10.0	12.0	5.0	8.0	6.0	13.0	9.0	11.0	10.0	13.0	13.0	10.0
Soluble P[2]	*	7.0	7.0	14.0	7.0	7.0	<5.0	6.0	6.0	9.0	9.0	7.0	8.0	13.0	10.0	9.0
August																
TKN	0.49	0.49	0.36	-	0.35	0.43	0.34	0.40	0.33	0.29	0.35	0.41	0.40	0.42	0.30	0.36
NO_3	0.02	0.01	0.01	<0.01	0.04	0.03	0.01	<0.01	0.03	0.03	0.02	0.03	0.03	0.02	0.04	0.05
Total P	7.0	12.0	6.0	14.0	10.0	10.0	<5.0	8.0	8.0	7.0	8.0	5.0	6.0	6.0	6.0	9.0
Soluble P	<5.0	<5.0	<5.0	6.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
October																
TKN	0.34	0.35	0.31	0.30	0.42	0.47	0.38	0.29	0.43	0.37	0.31	0.35	0.39	0.27	0.32	0.45
NO_3	0.06	0.07	0.04	0.05	0.03	0.03	<0.01	0.02	0.04	0.04	0.02	0.02	<0.01	<0.01	0.04	0.03
Total P	9.0	13.0	11.0	37.0	13.0	12.0	8.0	7.0	13.0	19.0	13.0	14.0	10.0	20.0	11.0	16.0
Soluble P	6.0	5.0	8.0	6.0	<5.0	<5.0	<5.0	<5.0	<5.0	7.0	<5.0	<5.0	7.0	<5.0	<5.0	<5.0

1 ppm
2 ppb
3 S - Surface, B - Bottom
* Sample damaged in transit
\- result suspect

TABLE 3.3-2

COMPARISON OF MEAN ANNUAL NUTRIENT CONCENTRATIONS IN SURFACE AND BOTTOM WATERS IN 1986 AND DURING PREOPERATIONAL STUDIES

	Snow L		Icy L		Abie L.		Slush L.		Marmion S.		Marmion N.		Anderson Dam	
Surface	86	Pre-op	86	Pre-op	86	Pre-op	86	Pre-op	86	Pre-op	86	Pre-op	86	Pre-op
Total P (ug/l)	8	14	8	15	11	<14	<6	<8	9	<11	7	<12	9	<18
Soluble P (ug/l)	<6	<6	<7	<7	<6	<5	<5	<4	<5	<6	<6	<5	<7	<7
TKN (mg/l)	0.40	0.35	0.39	0.39	0.36	0.30	0.33	0.30	0.39	0.29	0.35	0.31	0.38	0.38
NO_3 (mg/l)	<0.03	<0.24	<0.02	<0.13	<0.03	<0.85	<0.01	<0.39	0.03	<0.39	<0.02	<0.02	<0.02	<0.07
Bottom														
Total P (ug/l)	12	24	22	<28	11	18	8	20	13	<14	10	<14	13	24
Soluble P (ug/l)	<6	<6	9	<8	<6	<6	<7	<7	<7	<7	<6	<7	<8	<10
TKN (mg/l)	0.41	0.33	0.34	0.44	0.42	0.35	0.35	0.32	0.35	0.27	0.42	0.30	0.38	0.31
NO_3 (mg/l)	<0.03	<0.58	<0.02	<0.20	<0.02	<0.13	<0.01	<0.37	<0.03	<0.29	<0.02	<0.31	<0.01	<0.43

(C98)

TABLE 3.3-3

pH MEASUREMENTS IN BASINS OF COOLING WATER CIRCUIT

LOCATION		DATE									
		April 26-30	May 21-25	June 3-6	June 9-12	July 12-15	Aug. 6-11	Sept. 9-13	Sept. 15-18	Oct. 16-19	Oct. 20-23
Snow L.	S	7.6	7.4	7.7	7.6	7.3	7.8	7.7	7.6		7.9
	M	7.5	7.3	7.4	7.2	7.2	7.4	7.5	7.5		7.8
	B	7.4	6.6	6.9	6.1	6.5	6.8	6.8	7.2		7.6
Icy L.	S	7.5	7.6	7.8	7.7	7.5	7.9	7.8	7.6		7.6
	M	7.5	7.2	6.9	7.4	7.3	7.5	7.5	7.4		7.6
	B	7.6	6.6	6.3	6.8	6.4	6.8	7.1	7.2		7.1
Abie L.	S	7.5	7.7		7.8	7.6	7.9	7.8	7.8	8.2	8.0
	M	7.5	7.5		7.6	7.4	7.6	7.7	7.7	8.2	8.0
	B	7.5	6.7		6.9	6.6	6.6	7.5	7.6	8.3	7.9
Slush L.	S	6.9	7.7	7.6	7.7	7.5	7.6	7.5	7.5	7.4	6.9
	M	6.7	6.7	7.0	7.1	7.4	7.5	7.2	7.2	7.4	6.8
	B	6.1	6.4	5.7	5.2	6.0	6.1	6.1	6.5	7.5	6.7
Marmion South	S	7.3	7.7	7.8	7.8	7.7	8.0	7.7	7.5	8.0	8.0
	M	7.3	7.1	6.9	7.1	7.0	6.8	7.4	7.3	7.9	8.0
	B	7.6	6.9	6.5	6.8	6.5	6.7	6.7	7.0	7.9	7.7
Marmion Central	S	7.1	7.8	7.8	7.7	7.6	8.0	7.6	7.5	7.6	7.6
	M	7.2	7.2	7.1	7.3	7.5	7.3	7.5	7.5	7.6	7.5
	B	7.5	7.0	6.7	6.7	6.6	6.5	7.4	7.5	7.5	7.5
Marmion North	S	7.0	7.2	7.5	7.6	7.7	7.9	7.5	7.5	7.8	7.6
	M	6.9	7.0	6.9	7.0	7.4	6.9	7.2	7.4	7.8	7.5
	B	6.8	6.4	6.2	6.4	6.3	6.3	6.3	7.5	7.9	7.4
Anderson Dam	B	6.6	7.7	7.7	7.7	7.8	8.1	7.9	7.8	8.4	8.4
	M	6.9	7.4	7.4	7.5	7.6	7.9	7.9	7.7	8.3	8.3
	B	7.0	6.9	7.0	7.0	6.7	6.9	7.9	7.6	8.2	8.2
Lower Seine	S	6.8	7.8	7.8	7.8	7.7	8.1	7.7	7.5	7.3	7.2
	M	6.6	7.0	7.0	7.7	6.9	6.7	7.3	7.2	7.3	7.2
	B	6.3	6.7	6.4	7.0	6.4	6.3	6.8	6.5	7.3	7.2
Moose L.	S	7.2	7.8	7.7	7.8	7.8	8.1	7.8	7.6	7.9	8.3
	M	6.4	7.3	7.5	7.4	7.3	7.4	7.5	7.4	7.9	8.2
	B	5.4	7.2	6.5	6.6	6.6	6.7	6.5	6.9	7.8	8.0

S - Surface
M - Middepth
B - Bottom

TABLE 3.3-4

COMPARISON OF THE MEAN pH IN 1986 WITH PREOPERATIONAL OBSERVATIONS

LOCATION		1986*	1986	1981	1982	1983
Snow L.	S	7.6	7.6	-	7.0	7.0
	M	7.4	7.5	-	-	-
	B	6.7	6.8	-	6.8	7.3
Icy L.	S	7.6	7.7	6.7	7.1	7.6
	M	7.3	7.4	-	-	-
	B	6.7	6.8	6.6	7.1	7.3
Abie L.	S	7.8	7.9	-	7.4	7.4
	M	7.6	7.7	-	-	-
	B	7.0	6.8	-	7.3	7.2
Slush L.	S	7.3	7.4	6.0	7.0	7.2
	M	7.0	7.0	-	-	-
	B	5.9	6.4	5.9	6.4	6.8
Marmion South	S	7.7	7.9	6.4	7.0	7.4
	M	7.2	7.1	-	-	-
	B	6.7	6.6	6.3	6.8	7.2
Marmion Central	S	7.6	7.8	-	-	-
	M	7.3	7.3	-	-	-
	B	6.9	6.8	-	-	-
Marmion North	S	7.7	7.9	6.4	6.8	7.2
	M	7.2	7.1	-	-	-
	B	6.8	6.9	6.4	6.9	7.0
Anderson Dam	S	7.4	8.0	6.4	7.1	7.4
	M	7.5	7.7	-	-	-
	B	7.1	7.1	6.4	7.2	7.1
Lower Seine	S	7.4	7.6	6.3	-	-
	M	7.0	6.9	-	-	-
	B	6.6	6.6	6.1	-	-
Moose L.	S	7.7	8.0	-	-	-
	M	7.2	7.5	-	-	-
	B	6.3	7.0	-	-	-

*Mean of all observations, the remaining are May, August and October means.

S - Surface
M - Middepth
B - Bottom

species as observed during the surveys are presented in Table 4.1-1. Twenty-five of the macrophytes were submergents and floating-leafed, and 7 were emergents. The more common and widespread (occurring in at least four out of the five study lakes) submergent macrophytes included *Elodea canadensis* (waterweed), *Megalodonta beckii* (water marigold), *Myriophyllum exalbescens* (water milfoil), *Najas flexilis* (bushy pondweed), *Potamogeton epihydrus* (leafy pondweed), *Potamogeton richardsonii* (clasping-leafed pondweed), and *Potamogeton robbinsii* (Robbin's pondweed). The most common and widespread floating-leafed form was *Nymphaea odorata* (water lily) and the most common and widespread emergents were *Typha spp* (cattail) and *Scirpus spp* (bulrush). These species were also among the more common and widespread present in the study area in 1985. Taxa not recorded for the study lakes in previous years were *Chamaedaphne calyculata* (leatherleaf) and *Iris spp.* (iris).

Of the common and widespread submergents, *Elodea canadensis*, *Myriophyllum exalbescens*, *Najas flexilis*, *Potamogeton richardsonii*, and *P. robbinsii* are considered to be typical of hard water (Hutchinson 1975). *Potamogeton epihydrus* is considered to be eurytopic, occurring at a wide range of alkalinities.

The lowest number of taxa was found in Slush Lake (11) and highest number was found in Marmion Lake (27). Slush Lake had the lowest number of taxa in all previous study years except 1982 when the diversity in Snow Lake declined following the water drawdown. Marmion Lake had the highest number of taxa in all years except 1983 when the diversity in Snow Lake increased following the raising of its water level. The low species diversity in Slush Lake is probably related to a lack of suitable habitat due to the nature of its steep shoreline.

With the exception of Abie Lake, the number of taxa recorded for each lake was within the range observed between 1981 and 1985. Species diversity in Abie Lake during the 1986 survey was the lowest recorded. Differences in species numbers recorded for individual lakes between years may in part be due to differences in sampling efficiency since species of low abundance can easily be missed in a qualitative survey.

4.1.2 Distribution and Abundance of Macrophytes

The spatial distribution of macrophytes in some of the study areas conformed with the typical temperate zonation pattern of emergent, floating-leafed to submergent macrophyte dominance with increasing depth and distance from shore. This pattern was most pronounced in the West Bay of Icy Lake and the East Basin of Abie Lake. In the Northwest Bay of Snow Lake the floating-leafed zone was absent while in the East Bay of Icy Lake, Slush Lake and the two study locations in Marmion Lake there was a patchy distribution of one or more of these communities.

Snow Lake

As in 1985 the macrophyte community of Snow Lake differed most from the remaining lakes in the virtual absence of the floating-leafed forms and in the prominence of *Elodea canadensis*. Loss of habitat due to the 1981-1982 water drawdown as well as increased currents from the discharge may have prevented the recolonization of *Nymphaea odorata*. The increase in abundance of *Elodea canadensis* started in 1982 following the water drawdown. In 1985 it was more abundant than it had been during the preoperational study. However, in the present year, the first postoperational year, the predominance of this species near the discharge, in the northwest bay, appeared to have declined somewhat while the prominence of *Najas flexilis* increased.

Elodea canadensis was identified as a potentially problematic species in the preoperational

TABLE 4.1-1

MACROPHYTE SPECIES OBSERVED IN THE ATIKOKAN STUDY LAKES FROM 1981 THROUGH 1986

	Snow					Icy					Abie					Slush					Harmion				
Macrophytes:	81	82	83	85	86	81	82	83	85	86	81	82	83	85	86	81	82	83	85	86	81	82	83	85	86
Beckmannia syzigachne (Steud.) Fern, e																									
Brasenia schreberi Gmel., e																					X				
Calamagrostis canadensis (Michaux) Beauv., e											X	X	X	X	X					X					
Callitriche hermaphroditica L., s		X				X	X	X	X	X												X			
C. heterophylla Pursh., s																					X	X	X	X	X
Ceratophyllum demersum L., s		X																			X	X			X
Chamaedaphne calyculata (L.) Moench , e																					X	X	X	X	X
Dulichium arundinaceum (L.) Britton, e																									X
Eleocharis acicularis (L.) R. & S., s		X				X					X					X				X					
E. paulustris (L.) R. & S., e											X	X									X	X		X	X
Elodea canadensis (Michx.) Rich., s	X	X	X	X	X	X	X	X	X	X	X			X	X	X					X		X		
Equisetum sp., e	X					X					X										X	X	X	X	X
Eriocaulon septangulare With., s	X										X										X				
Glyceria borealis (Nash) Batch., F		X						X				X	X												
G. canadensis (Michx.) Trin, s																						X	X	X	X
G. grandis S. Watson, e													X												
Hippurus vulgaris L., e																X	X				X	X		X	
Isoetes spp., s																X	X							X	
Iris sp			X										X												
Juncus effusus L., e				X					X																X
Lemna spp., f		X								X														X	X
Lobelia dortmanna L., e	X															X									
Megalodonta beckii (Torr.), s				X				X	X				X	X											
Mimulus ringens L., e										X															
Myriophyllum alterniflorum D.C., s	X						X		X					X	X	X					X				
M. exalbescens Fern., s	X		X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X
Najas flexilis (Wild.) R. & S., s	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Nuphar sp., f	X					X		X	X	X	X	X	X	X	X	X	X	X	X						
Nymphaea odorata Ait., f	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X						
Nymphaea tetragona Georgi., f																					X	X	X	X	X
Polygonum natans Eat., f											X														
Potamogeton alpinus Balbis, s,f								X	X	X	X	X	X					X	X		X				
P. amplifolius Tuckerm., s			X																		X				
P. epihydrus Raf., s,f	X		X	X	X			X		X					X		X	X	X	X	X	X	X	X	X
P. foloisus Raf., s	X	X	X	X	X		X		X	X			X		X	X	X	X	X	X	X	X	X	X	X
P. friesii Rupr., s		X	X	X	X			X	X												X	X			
P. gramineus L., s.f.						X			X	X		X		X											
P. natans L, s,f	X			X			X			X	X	X	X	X	X						X		X	X	X
P. obtusifolius Mert & Koch., s							X	X	X				X	X							X	X		X	
P. pectinatus L., s		X	X	X			X																		
P. praelongus Wulfen., s							X														X				
P. pusillus L., s					X			X																	
P. richardsonii (Benn.) Rydb., s	X		X	X	X			X													X		X	X	X
P. robbinsii Oakes., s	X		X	X	X		X	X	X	X			X	X	X						X	X		X	X
P. spirillus Tuckerm., s,f	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P. strictifolius Benn., s				X	X																X			X	X
P. vaseyi Robbins, s,f				X	X	X		X				X									X	X	X	X	X
P. zosteriformis Fern., s														X											
Ranunculus tricophyllus Chaix., s			X	X			X	X		X											X	X	X	X	X
Rorippa islandica (Oeder.)Borbas, s	X	X	X	X		X	X	X	X	X	X		X								X	X	X	X	X
Sagittaria spp., e,s										X											X				
Scirpus spp., e,s	X		X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Sium suave Walt., e		X	X	X				X	X							X	X		X	X	X	X		X	X
Sparganium fluctuans (Morong.) Robinson, f	X									X	X			X							X	X		X	
Typha spp., e								X	X				X											X	
Utricularia vulgaris L., s		X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Vallisneria americana Michx., s	X				X			X		X	X	X	X	X	X						X	X			
Charophytes:	X		X			X	X	X	X	X	X	X	X	X				X			X				
Chara sp., s	X	X	X	X	X	X	X	X		X	X	X	X	X							X			X	X
unidentified Charophytes, s		X																			X		X		
Total Number of Taxa	21	9	22	17	19	15	17	17	29	19	25	17	18	24	18	10	11	12	10	11	34	30	21	29	27

summary report (OHRD Report No 86-38-K). It is well adapted to spread by vegetative means since its stems are easily broken and readily form adventitious roots (St. John 1965). In addition it lacks a dormancy mechanism which permits it to grow in the winter and ice-free conditions created by the thermal discharge would give it a competitive advantage. The proliferation of *Elodea canadensis* in Lake Wabamun was attributed to the absence of winter ice cover in areas heated by the thermal plume of Wabamun GS (Haag and Gorham 1977). Other species present in Snow Lake that are known to be photosynthetically active in winter are *Potamogeton amplifolius* and *P. robbinsii* (Boylen and Sheldon 1976).

The distribution and abundance of macrophytes in Snow lake (Figure 4.1-1) were similar to those of 1985 with dense cover and high diversity found in the protected bays and indented areas along all of the shoreline except the southwestern stretch where growth was sparse. As in 1983 and 1985, large stretches of the emergents *Typha spp* and *Scirpus spp* (bulrush) occurred in the areas exposed during the water drawdown in 1981. As in 1985, *Najas flexilis* was the most common submergent along the northshore while *Elodea canadensis* was the most common along most of the remainder of the shoreline.

In the northwest bay, the area selected for detailed study, the distribution of submerged macrophytes was similar to that of 1985 (Figures 4.1-2 and 4.1-3). The density (% cover) of the submerged macrophytes was lower along the western shore of the bay, north of the discharge (Figure 4.1-3). Areas of lower density were also observed in the centre of the eastern part of the bay. The density of the submerged macrophytes had increased over that observed in 1985 along the length of transect 4 near the discharge and close to the shores at both ends of transects 1, 2 and 3. Species diversity close to the shores had also increased over 1985.

Icy Lake

The West Bay

The distribution of the emergent and submergent macrophytes in this bay was similar to that of 1985 while that of the floating-leafed forms had increased along the southeast shore of the bay (Figure 4.1-4 and 4.1-5). The size of the *Potamogeton natans* patch present in the west arm of the bay in 1985 had increased with a large patch of dense growth also found in the north end of the bay.

The submerged vegetation cover was heavy in the west arm and centre of the bay and was low in the northern section of the bay. The density of the submergent macrophytes in the centre of the northern section was lower than it had been in 1985. Sedimentation was high in the northern arm and the *Potamogeton robbinsii* in this area appeared stunted.

The East Bay

The distribution of the macrophytes in the east bay of Icy Lake was quite similar to that of 1985 (Figures 4.1-6 and 4.1-7) with heavy submergent growth confined to the west end, emergents occurring along most of the shores and occasional patches of floating-leafed forms found throughout the bay. Patches of submergents present in the eastern half of the bay in 1985 were confined to the occasional small patch of *Potamogeton robbinsii* and *Myriophyllum exalbescens* in 1986. However, sedimentation in this area was very heavy and covered some of the submergent vegetation.

The predominant emergents were *Scirpus spp* and *Typha spp.* The patches of floating-leafed macrophytes at the centre of the bay consisted of *Nymphaea odorata* and in the indents along the

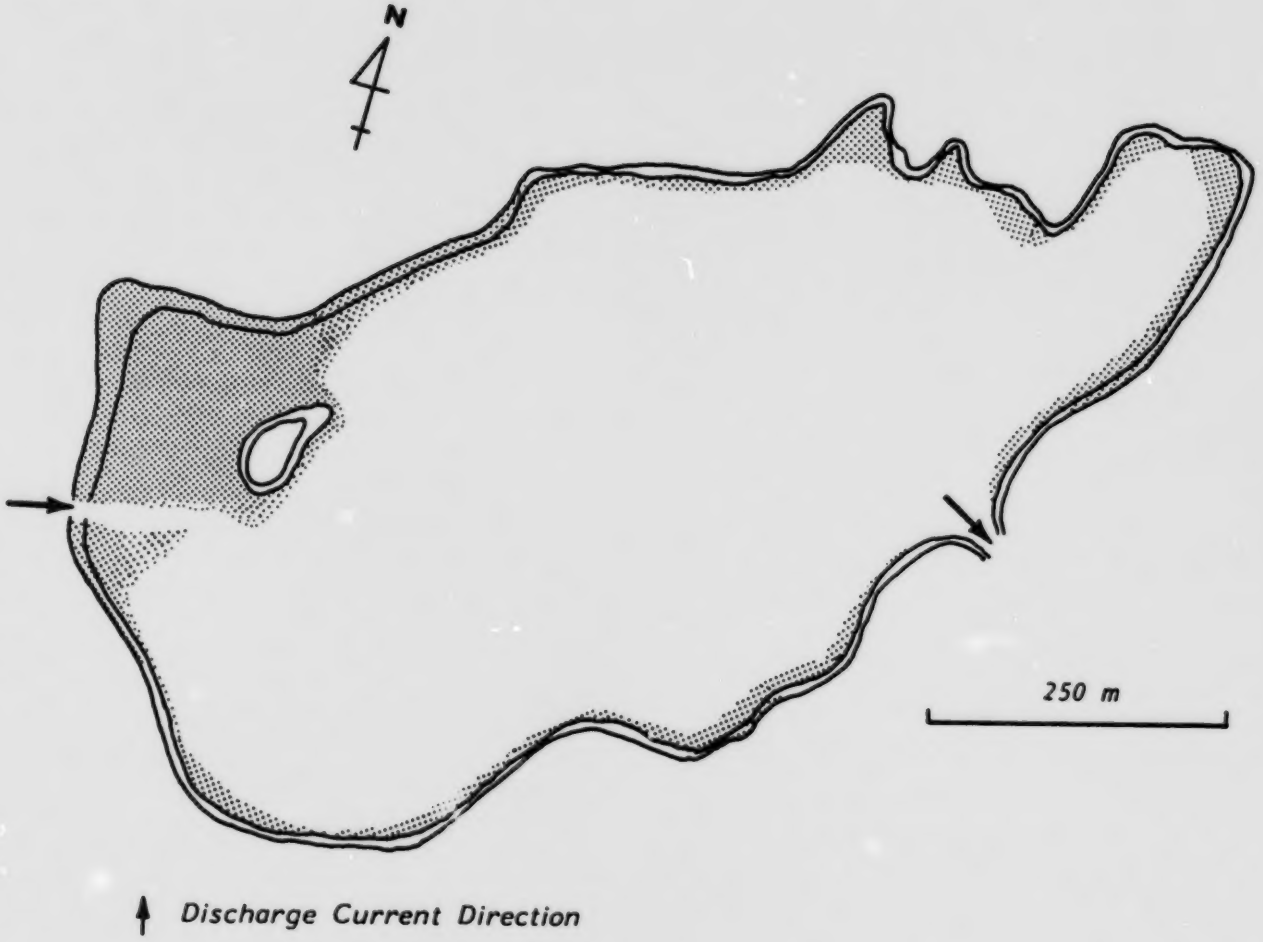


FIGURE 4.1-1
DISTRIBUTION OF MACROPHYTES IN SNOW LAKE IN 1986

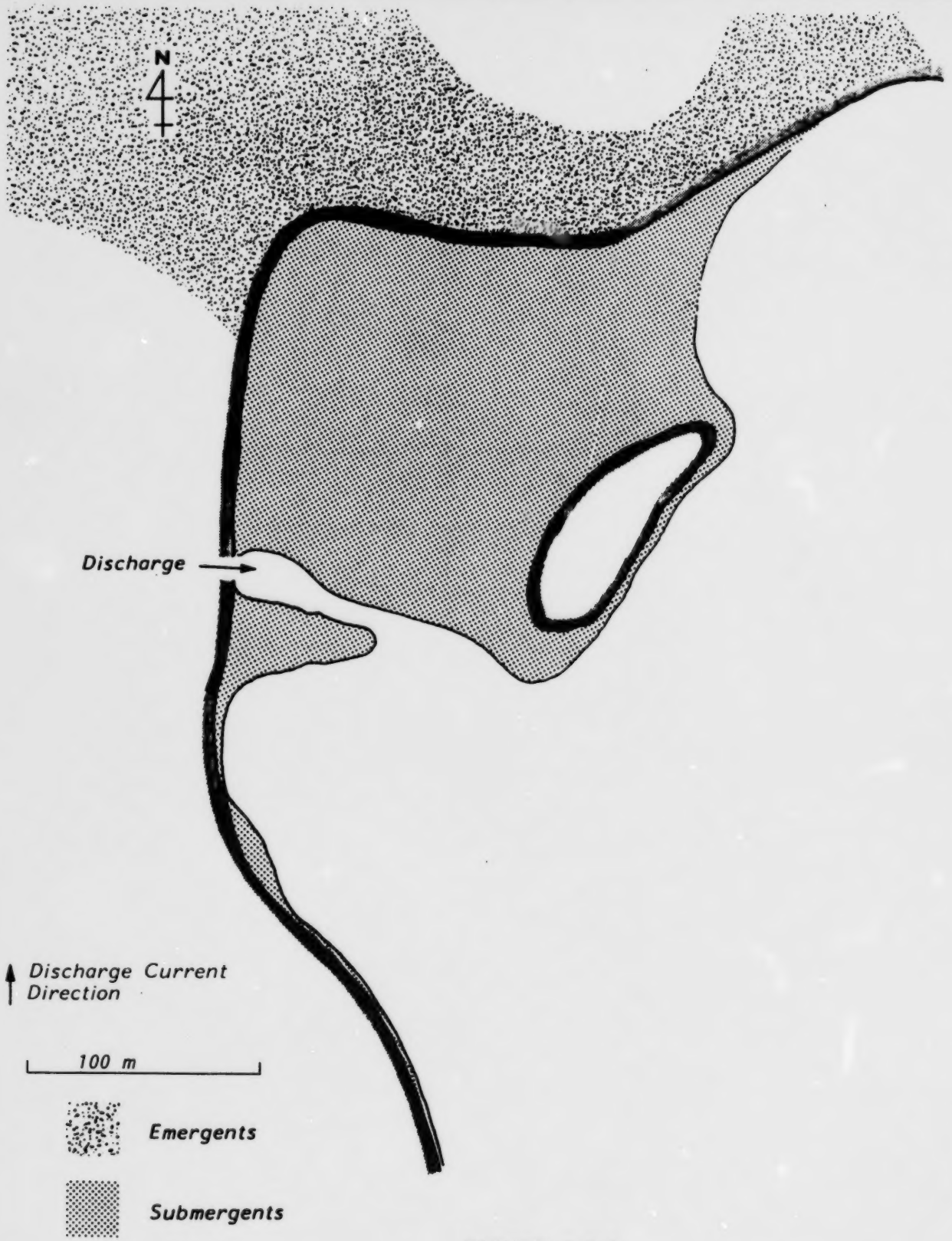


FIGURE 4.1-2

DISTRIBUTION OF MACROPHYTES ALONG WEST SHORE OF SNOW LAKE IN 1986

88-225

175670-RD

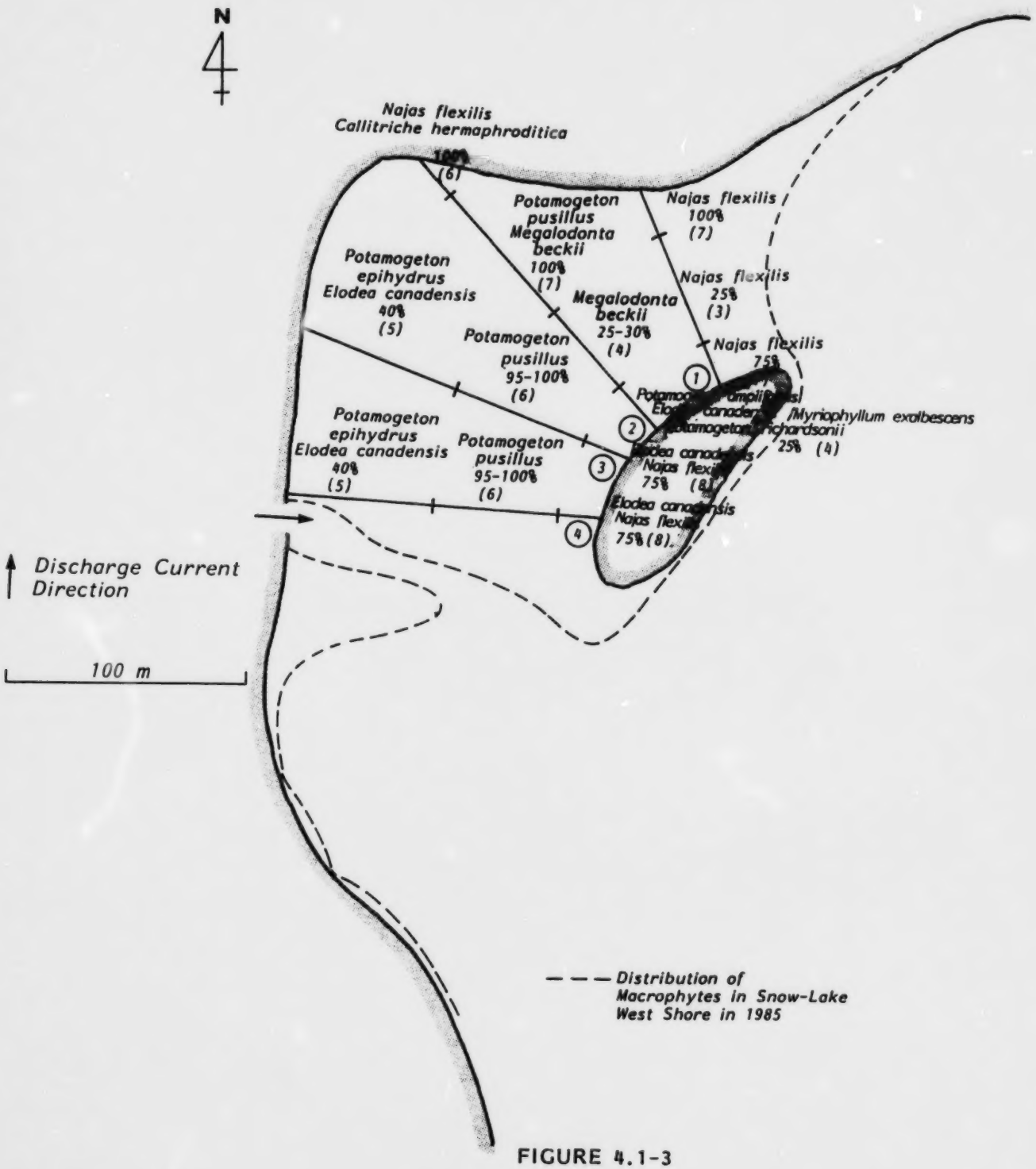


FIGURE 4.1-3

DOMINANT SUBMERGENT MACROPHYTES (≤50%), PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢——⊣) ALONG WESTERN SHORE OF SNOW LAKE, 1986

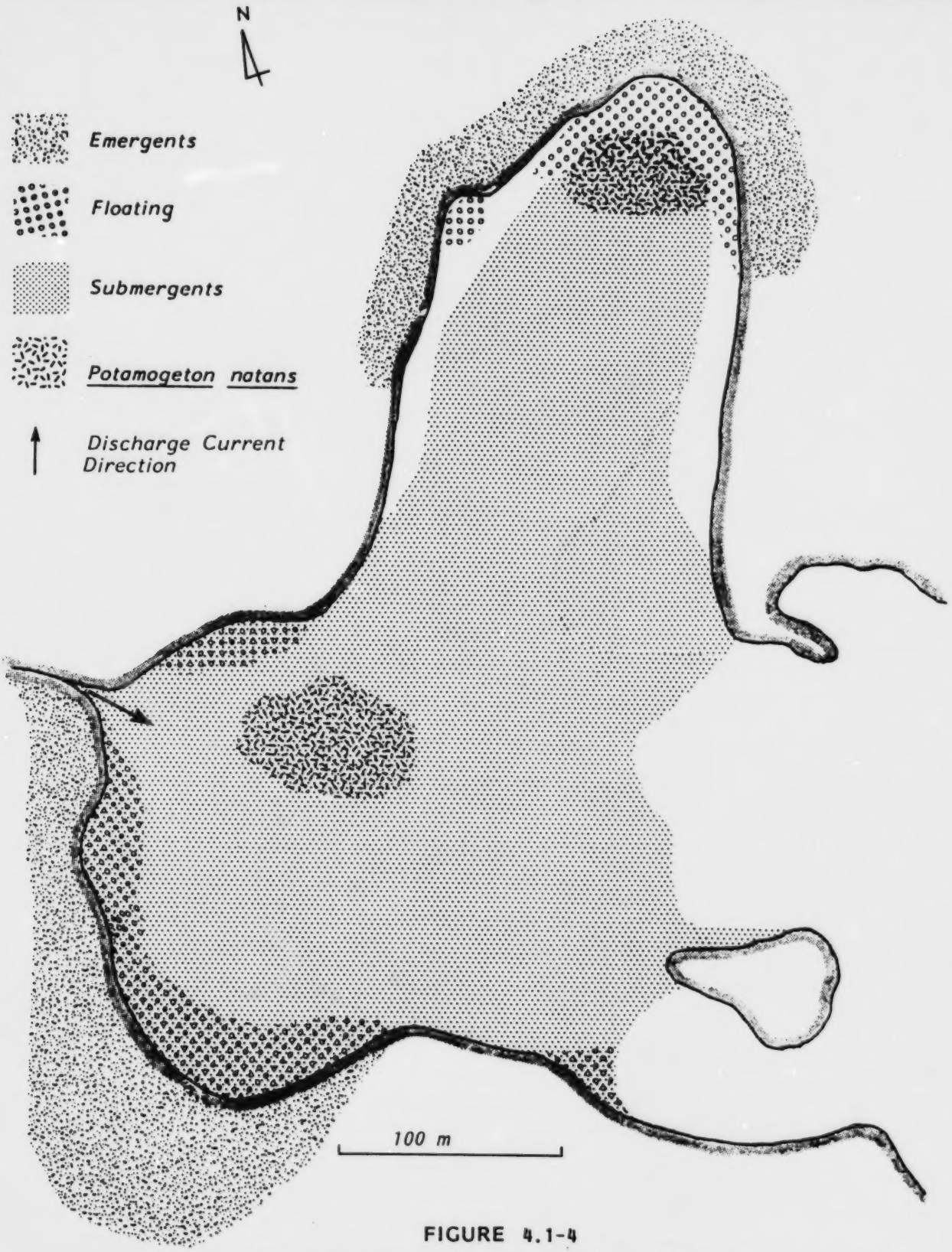


FIGURE 4.1-4
DISTRIBUTION OF MACROPHYTES IN WEST BAY OF ICY LAKE IN 1986

88-225

175671-RD

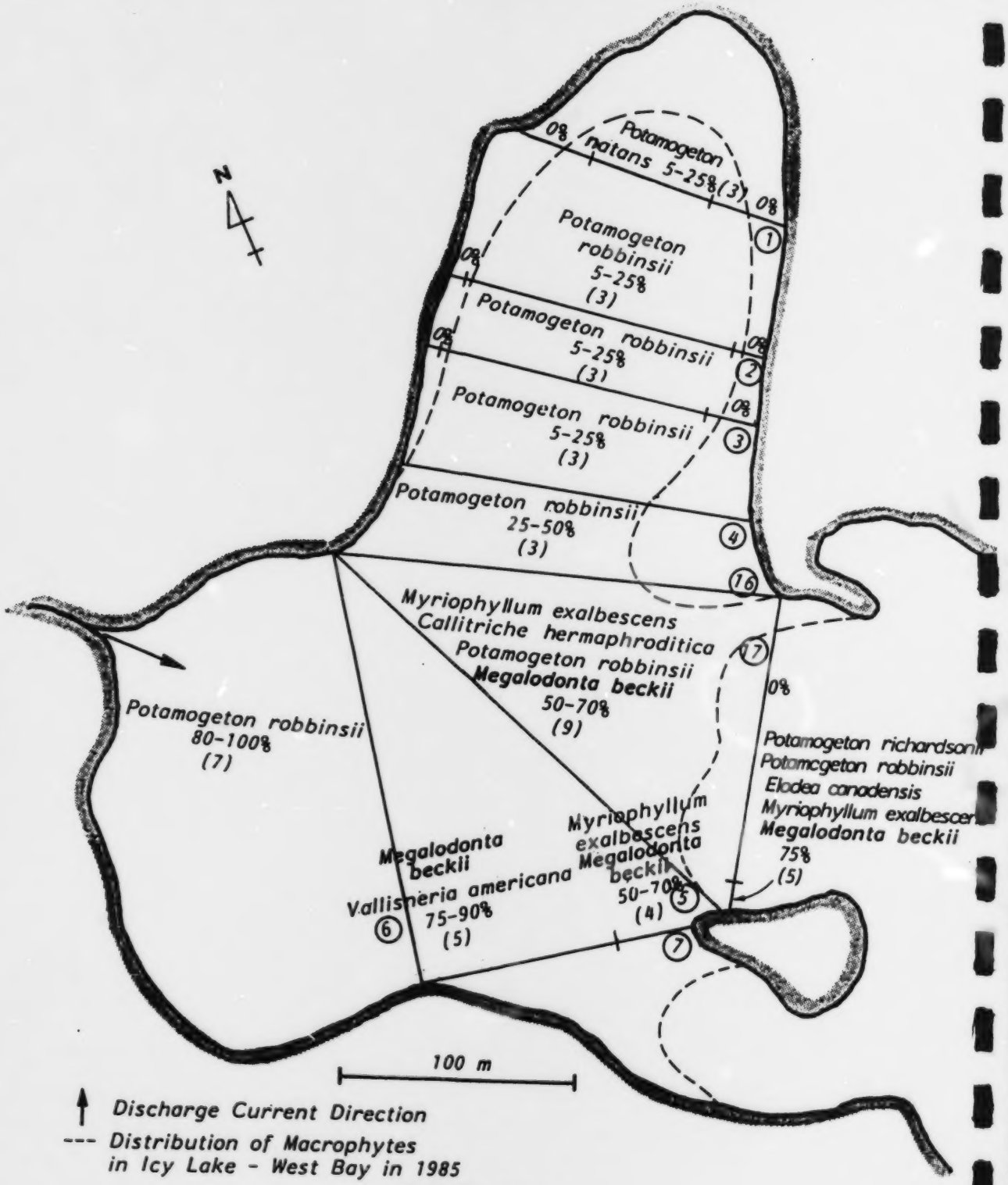


FIGURE 4.1-5

DOMINANT SUBMERGENT MACROPHYTES (≤50%), PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) IN WEST BAY OF ICY LAKE, 1986

88-225

175666-R

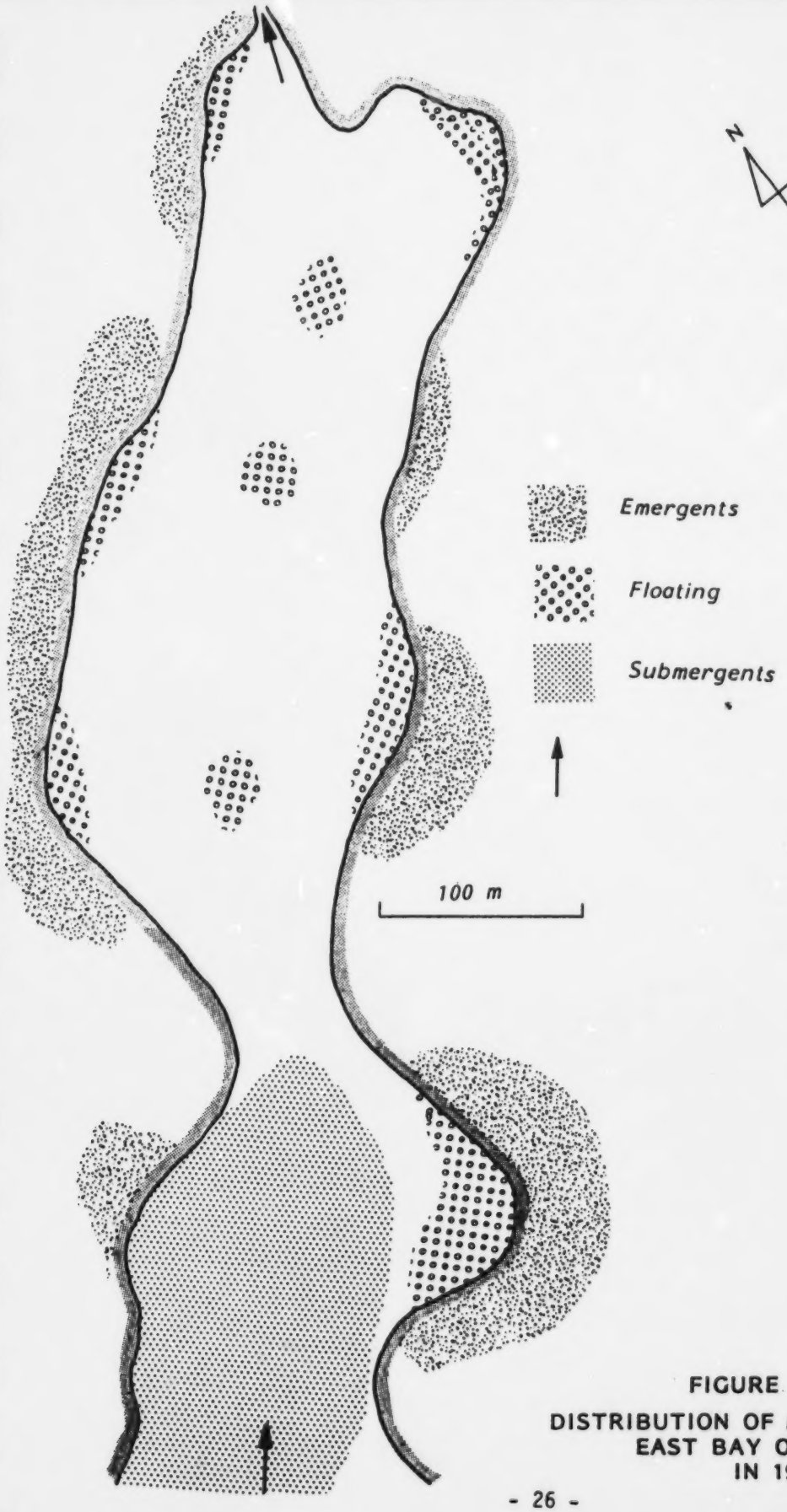


FIGURE 4.1-6
DISTRIBUTION OF MACROPHYTES IN
EAST BAY OF ICY LAKE
IN 1986

88-225
175672-RD

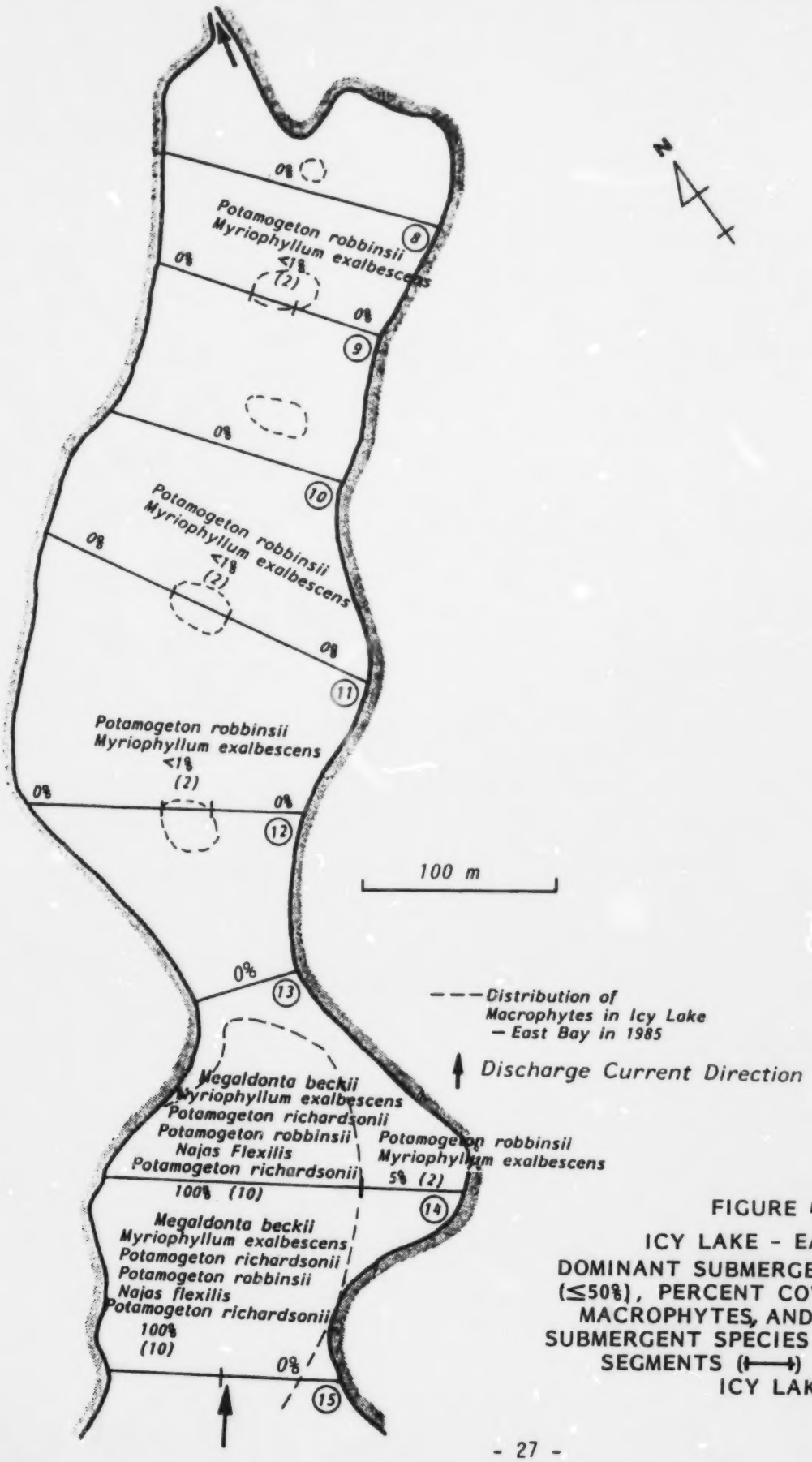


FIGURE 4.1-7

ICY LAKE - EAST BAY
DOMINANT SUBMERGENT MACROPHYTES (≤50%), PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT SPECIES ( ) ON TRANSECT SEGMENTS (⟷) IN EAST BAY OF ICY LAKE, 1986

shore it was mixed in with *Sparganium fluctuans* and *Sagittaria spp.* In the area of heavy submergent cover the species diversity was high. The species diversity in this bay increased between 1983 and 1985 when it was suggested that the heterogeneity was a consequence of disturbance which resulted in remnants of the previous submergent community coexisting with new colonizers.

There was a lack of dominance of the submergent community with the relative abundance of *Megalodonta beckii* only slightly higher than those of the remaining species. The abundance of *Elodea canadensis*, the most common species observed along transect 14 in the area of heavy submergent growth in 1985, was very low in 1986.

Abie Lake

The distribution of macrophytes extended beyond the 1985 distribution at the northeastern outlet such that vegetation now occurred throughout the east basin of Abie Lake (Figures 4.1-8 and 4.1-9). Submergent vegetation cover was heavy closer to shore and was lower at the centre of the basin.

Typha spp was the most common emergent form and *Nymphaea odorata* the most common floating-leafed form. The predominant submergents close to shore included *Potamogeton gramineus, P. robbinsii* and *Utricularia vulgaris*. Further offshore, *Potamogeton robbinsii* was the most common species followed by *Najas flexilis* in still deeper water. The abundance of *Najas flexilis* had declined between 1981 and 1983 and increased between 1983 and 1985 when it was the most common species in the basin. *Najas flexilis* is among the vegetation described as choice duck food (Fassett 1975).

Slush Lake

As in the previous study years, the vegetation in Slush lake was sparse and was characterized by occasional small patches of emergents, lilies and pondweeds along the shore (Figure 4.1-10).

The most common macrophytes were the emergents, *Typha spp* and *Scirpus spp*, the floating-leafed *Nymphaea odorata*, and the submergents *Potamogeton amplifolius* and *P. epihydrus*. *Sagittaria spp* was prominent in its floating form.

Marmion Lake

Near Abie Lake

The distribution of the submergents had increased between the island and the mainland such that the vegetation cover was now continuous between the two shores (Figures 4.1-11 and 4.1-12). The submergent vegetation also extended further south along the eastshore of the island over that observed in 1985.

Heavy macrophyte cover was found along the shore of the island while cover along the mainland shore was substantially lower.

The emergents consisted of *Sagittaria spp* mixed in with *Juncus effusus*, *Scirpus spp* and *Chamaedaphne calyculata*. The main floating-leafed form was *Nymphaea odorata*. As in previous years *Potamogeton zosteriformis* was one of the more common submergents around the island and co-dominated with either *Potamogeton epihydrus*, *Myriophyllum alterniflorum*, or *P. robbinsii*. *P. richardsonii* was the most common submergent on the mainland side.

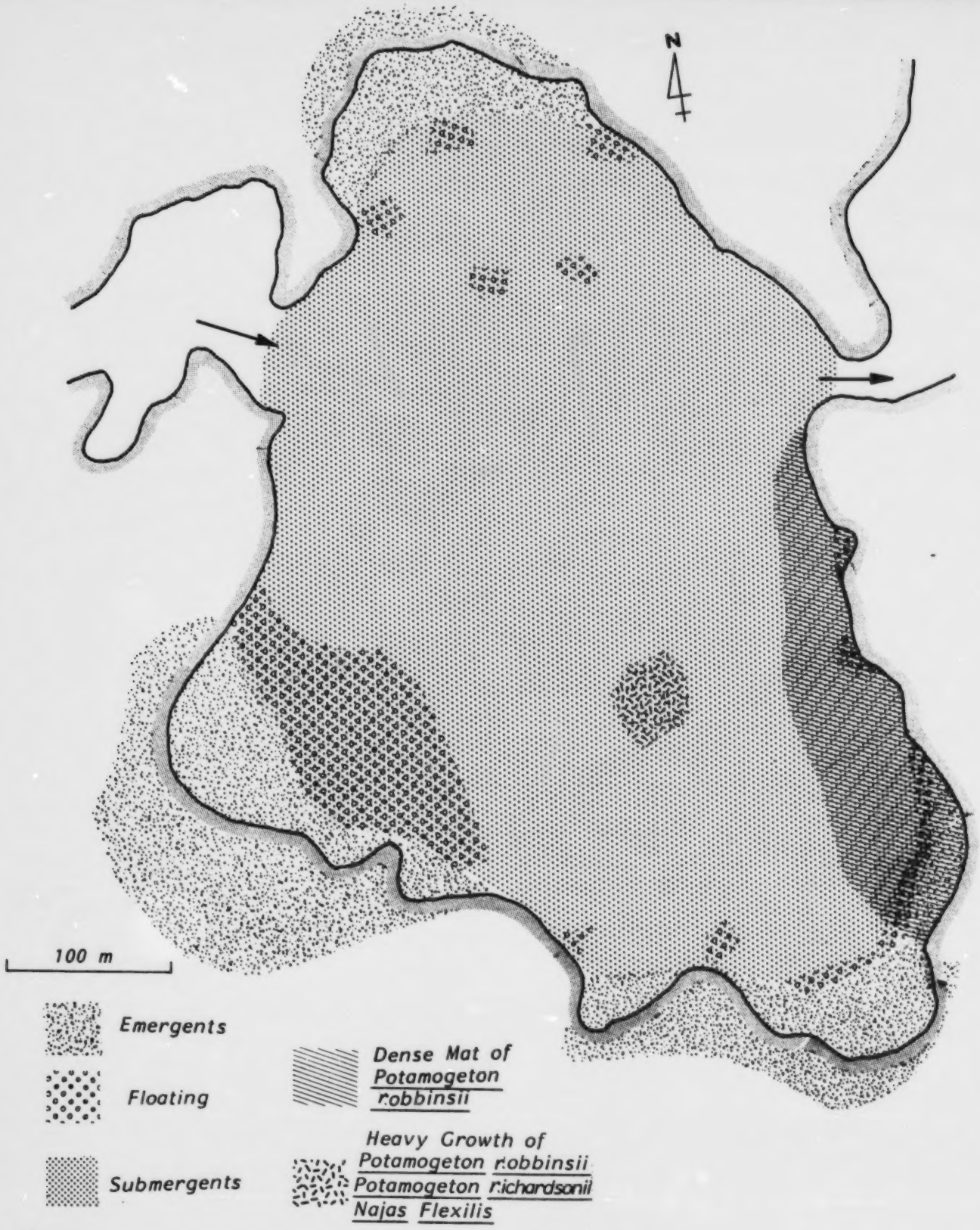


FIGURE 4.1-8

DISTRIBUTION OF MACROPHYTES IN EAST BASIN OF ABIE LAKE IN 1986

88-225 175669

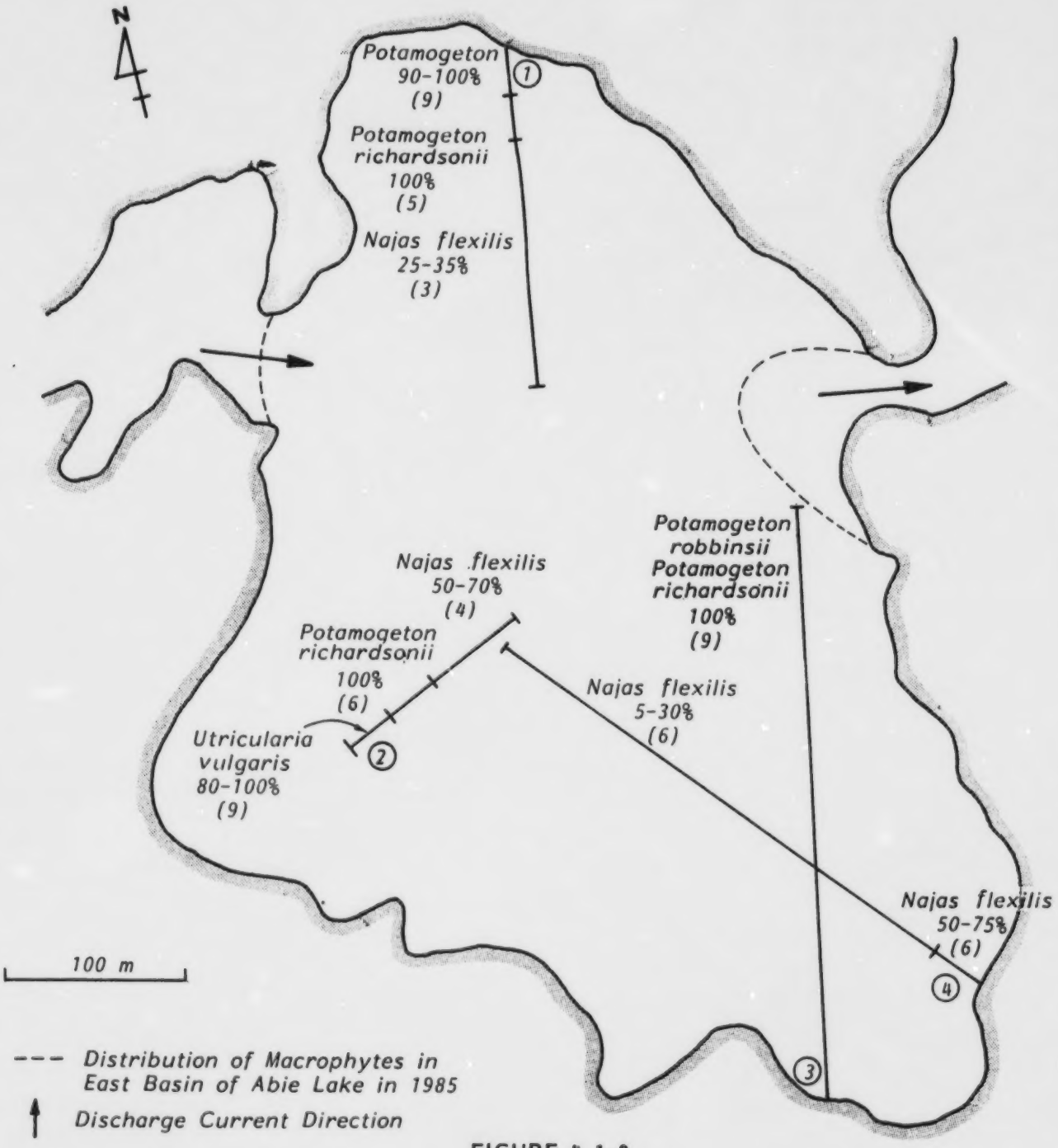


FIGURE 4.1-9

DOMINANT SUBMERGENT MACROPHYTES (≥50%), PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢—⊣) IN EAST BASIN OF ABIE LAKE, 1986

88-225

175667-RD

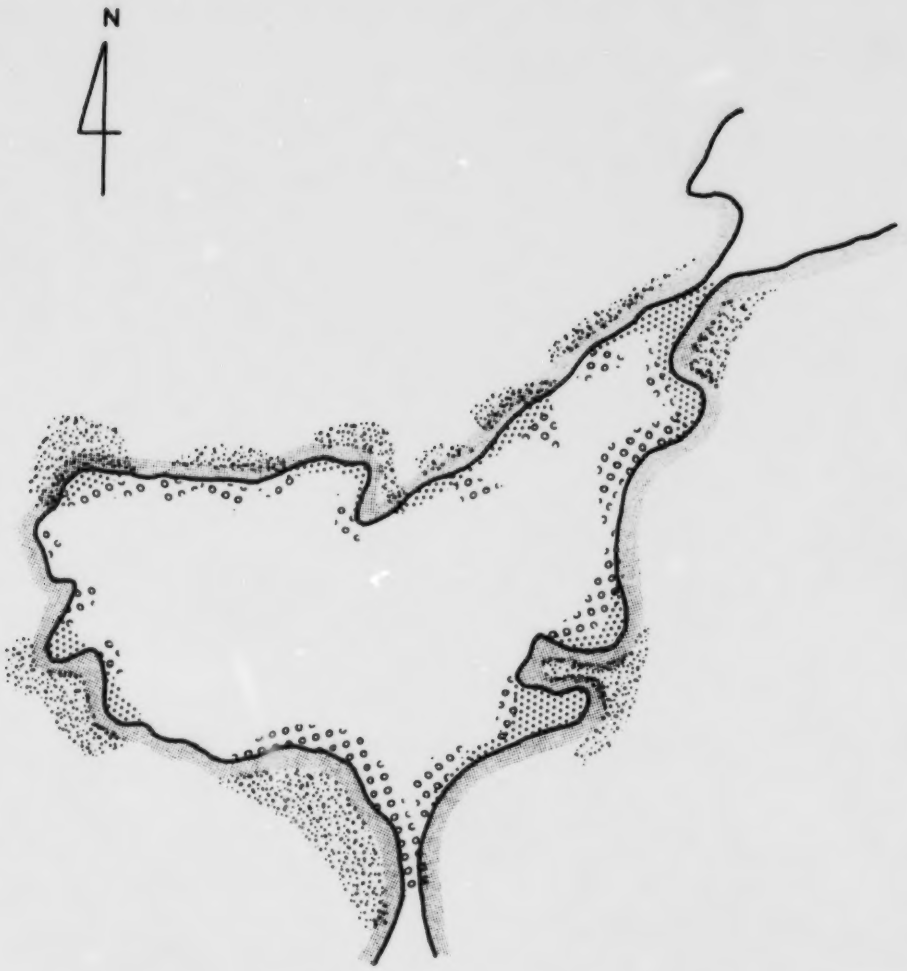


FIGURE 4.1-10
DISTRIBUTION OF MACROPHYTES IN
SLUSH LAKE IN 1986

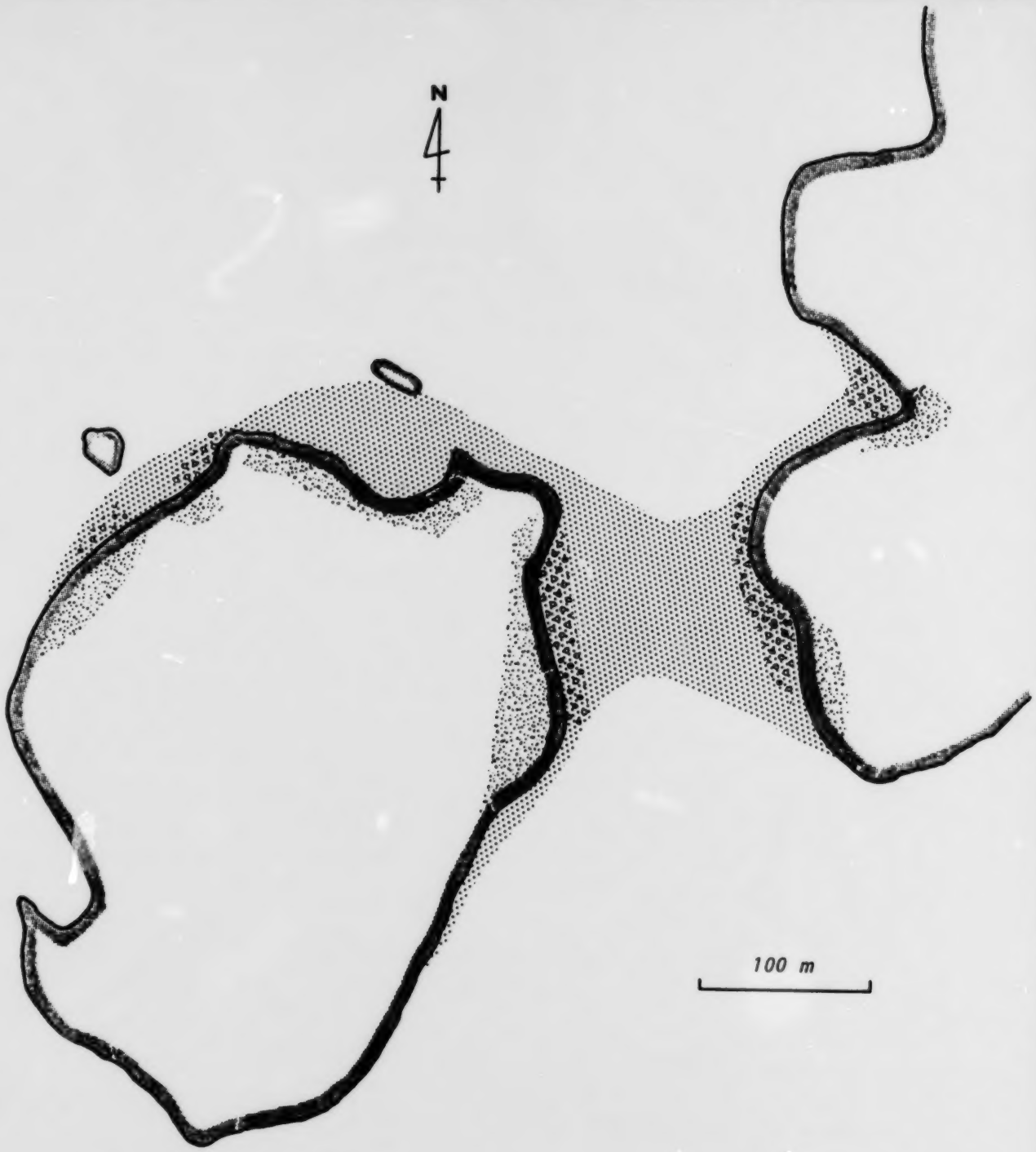


FIGURE 4.1-11

DISTRIBUTION OF MACROPHYTES IN MARMION LAKE NEAR ABIE LAKE IN 1986

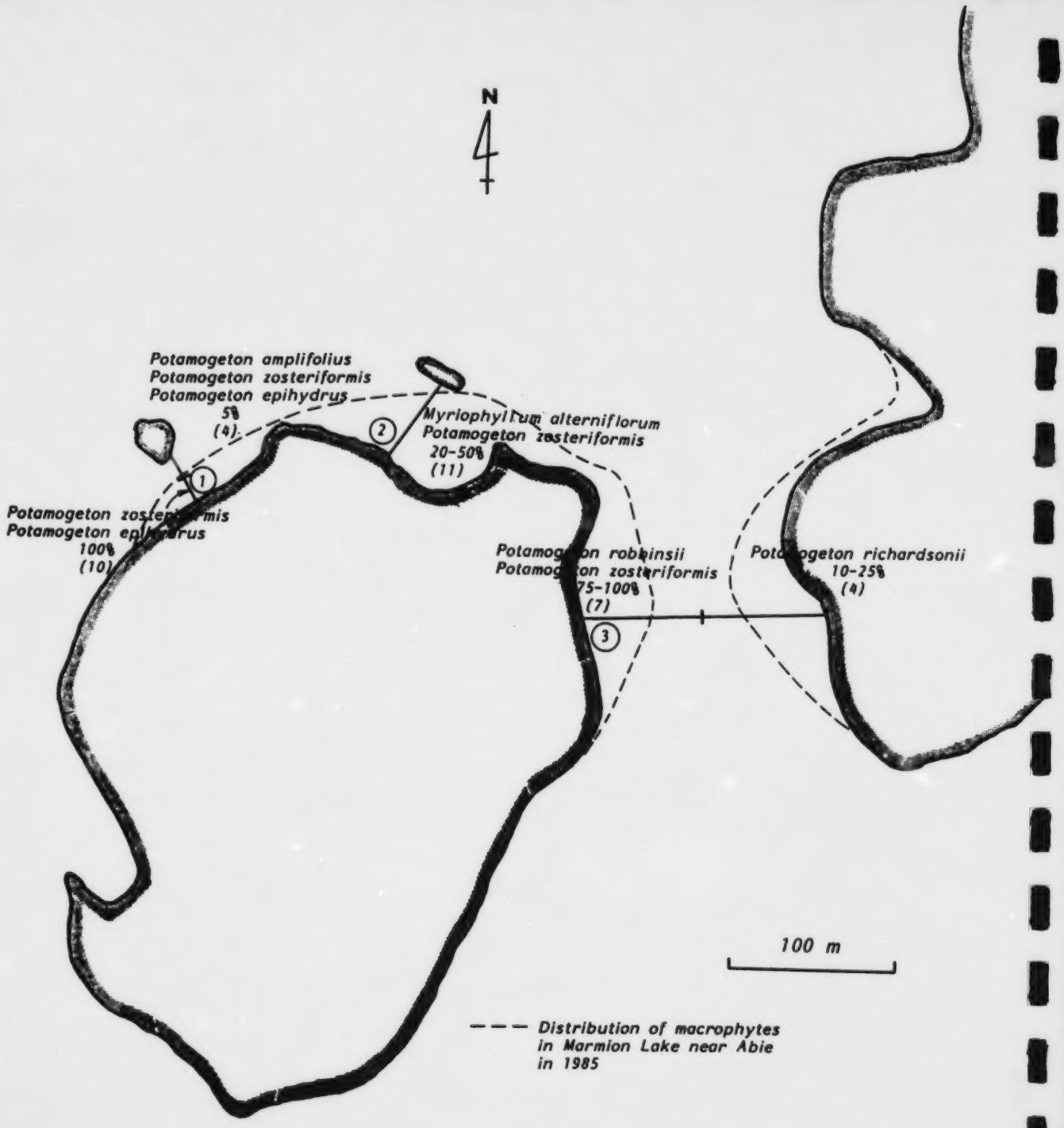


FIGURE 4.1-12

DOMINANT SUBMERGENT MACROPHYTES (≤50%), PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢—⊣) IN MARMION LAKE NEAR ABIE LAKE, 1986

Near Anderson Dam

The distribution of submergent macrophytes in Marmion Lake near Anderson dam was similar to that observed in 1985 (Figures 4.1-13 and 4.1-14). This was more extensive than that observed during the preoperational study with vegetation spreading further south and west along the western shore of the bay. A similar increase in distribution was observed for the floating-leafed forms in 1986. The growth of emergents, as in previous years, was sparse.

Cover of the submergent macrophytes was very heavy all along the transects. At depths beyond the special study area, the vegetation typically consisted of deep water submergents with floating leaf components.

Ceratophyllum demersum was either dominant or co-dominant along the [illegible]. Other prominent species included *Potamogeton richardsonii* along the two northern transects (transect 1 and 2), *Myriophyllum exalbescens* along the two northern transects and the southern most transect (transect 4), and *Ranunculus tricophyllus* along the southern most transect.

Due to poor visibility, species composition could not be precisely determined in 1985, precluding a comparison of 1985 and 1986 species composition for this area.

Overview

The concerns over macrophytes in the Atikokan TGS cooling circuit lakes during the postoperational phase are the potential effects of water level stabilization due to the construction of dams, weirs and channels as well as the discharge of cooling water (Greig et al 1984). The stabilization of water levels may result in an increase in macrophyte distribution while the thermal effluent may affect the distribution as well as the density of macrophytes. The discharge of thermal effluent from the Wabamun Generating Station in Calgary resulted in rapid increases in the distribution and biomass of *Elodea canadensis*, previously a minor species in Lake Wabamun, to a point where it interfered with recreational amenities (Haag and Gorham 1977).

Possible effects of construction on the macrophytes of the cooling circuit lakes identified during the preoperational phase included the increased abundance of *E. canadensis* associated with the lowering of the water level by 2-3 m (OHRD Report No 86-38-K). The lowering of the water level allowed for the colonization of substrate which was not vegetated in 1981 while substrate exposed by the drawdown was taken over by emergents. With the raising of the water level between 1982 and 1983, *E. canadensis* spread to the shallow zone forming a discontinuous band around the lake in water 1-3 m deep. The macrophytes of Snow Lake may also have been affected by sewage discharged through a marsh into a stream draining into the northwest corner of the lake during the preoperational period. The widening of the stream joining Icy and Abie Lakes may have altered flow conditions through the east bay of Icy lake resulting in an increase in submergent cover in the center of the bay between 1981 and 1982. Lowered water levels as a result of reduced flow into this bay may have caused extensive winterkill resulting in a marked reduction in the density of the submergents in 1983.

The most common and widespread macrophytes in the study area in 1986 were the submergents, *Elodea canadensis*, *Myriophyllum exalbescens*, *Najas flexilis*, *Potamogeton epihydrus*, *P. richardsonii*, and *Potamogeton robbinsii*, the floating-leafed *Nymphaea*, and the emergent, *Typha spp.* As in previous study years the most common submergents were typical of hard water habitats.

FIGURE 4.1-13

DISTRIBUTION OF MACROPHYTES IN MARMION LAKE NEAR ANDERSON DAM IN 1986

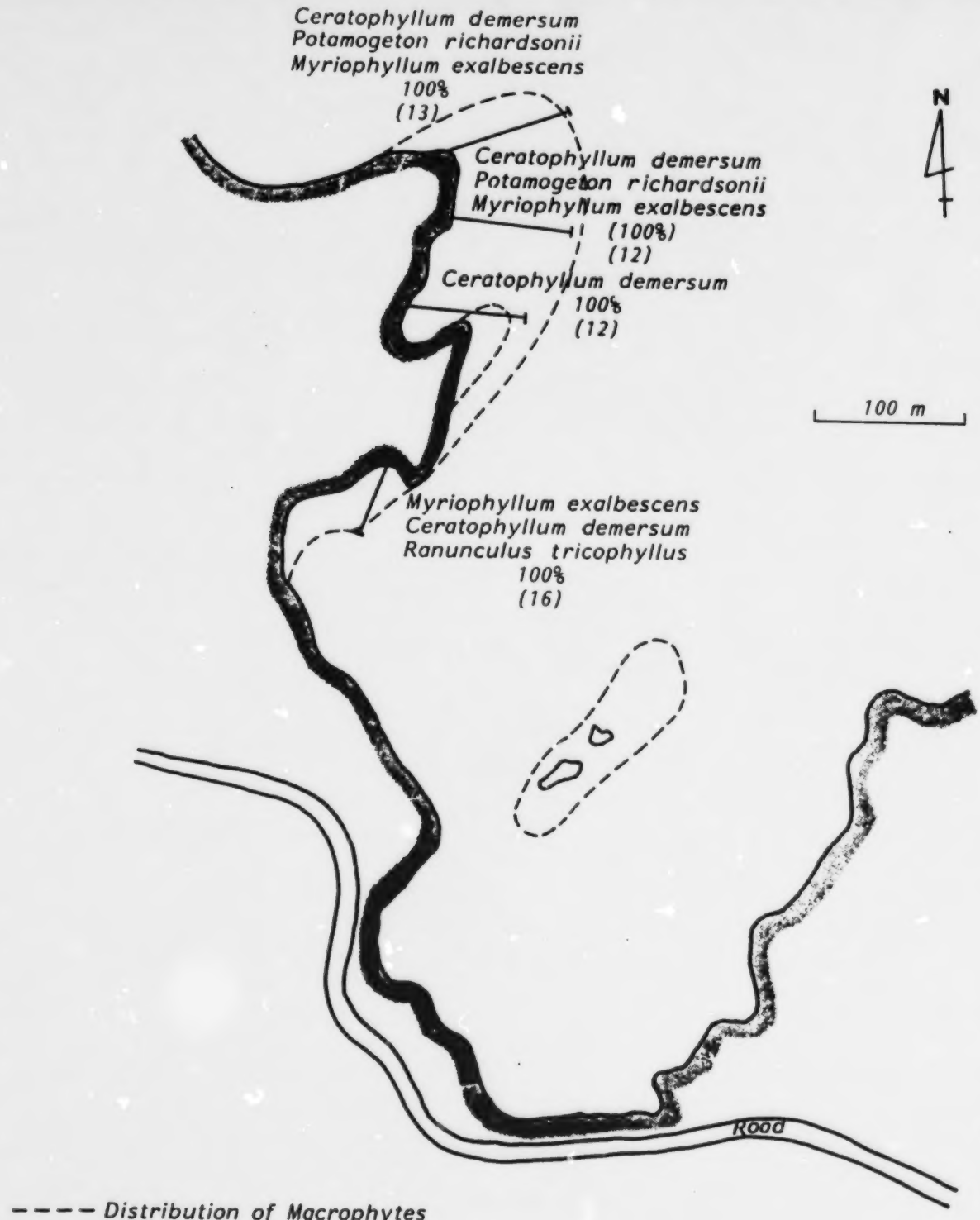


FIGURE 4.1-14

DOMINANT SUBMERGENT MACROPHYTES (≥50%), PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢—⊣) IN MARMION LAKE NEAR ANDERSON DAM, 1986

The typical temperate zonation pattern of emergent, floating-leafed to submergent macrophyte dominance with increasing depth and distance from shore was most pronounced in the West Bay of Icy Lake and the East Basin of Abie Lake. The floating-leaf zone was absent from the northwest bay of Snow Lake and, in the remaining locations, there was a patchy distribution of one or more of these communities.

Najas flexilis and *Elodea canadensis* were the most abundant submergents present in the northwest bay of Snow Lake. *Potamogeton robbinsii*, *Myriophyllum exalbescens* and *Megalodonta beckii* were among the most common submergents in the west and east bays of Icy Lake. In the east basin of Abie Lake *Potamogeton gramineus*, *P. robbinsii* and *Utricularia vulgaris* were the most common submergents near shore followed by *P. robbinsii* further offshore and by *Najas flexilis* in deeper water still. *Potamogeton amplifolius* and *P. epihydrus* were the most abundant submergents in Slush Lake. In Marmion Lake near Abie Lake *Potamogeton zosteriformis*, *P. epihydrus*, *P. amplifolius*, *P. robbinsii*, and *Myriophyllum alterniflorum* were the most abundant forms. In Marmion Lake near Anderson Dam *Ceratophyllum demersum* was the most common submergent.

The density of submergent macrophytes in the northwest bay of Snow Lake increased between 1985 and 1986. This increase may have been related to the thermal discharge; however, the density had also increased between 1983 and 1985 in the absence of a thermal discharge. Consequently there may have been other factors involved in the increased abundance observed in 1986. An increase in the distribution of macrophytes was observed in the special study areas in Abie and Marmion Lakes which may in part have been related to water level stabilization. The distribution in these locations had also increased between 1983 and 1985. The construction of weirs and dams had been completed by 1985 such that water levels had been stabilized. Currents in the connecting channels and outfalls may have been responsible for high sedimentation observed in the west and east bays of Icy Lake. Sedimentation in the east bay of Icy Lake resulted in the loss of submergent macrophytes in the eastern portion of the bay resulting in a loss of potential habitat for forage fish.

4.2 Fish

4.2.1 Gill Netting

The catches in gill nets set during 1986 are listed in Appendix 4 and summarized in Table 4.2-1. Averaged over all locations, the coregonids, cisco and lake whitefish, were the most frequently collected species during 1986. Cisco was the most commonly collected species in Abie Lake and at Marmion Lake Central and North and Lower Seine while lake whitefish was the most common species at Marmion South. Of the remaining locations, northern pike was the most common species in Moose Lake and common white sucker in Snow and Icy Lakes and at Anderson Dam. Cisco and northern pike were equally abundant in Slush Lake. Lake whitefish were collected in Slush Lake during 1986, the first time since 1981. Walleye, collected from Moose Lake in 1981 when the Lake was drawn down for construction of the intake, have not been collected from Moose Lake since.

Prior to 1986, gill nets were set for a nominal 2-hr period at all locations; however, in 1986 nets were set for approximately 24-hr at Marmion Central and North and at Lower Seine. A comparison of the catch per 2-hr of set at these locations in 1986 with those for 1982 through 1985 (Table 4.2-2) indicated that in the 24-hr sets the contribution of cisco to the total catch increased relative to the 2-hr sets while that of white sucker decreased. Averaged over the three locations, the catch of cisco and white sucker per 2-hr of set in 1986 fell outside the range of values reported for 1982 through 1985. This variation is likely due to differences in diel activity

TABLE 4.2-1

CATCH AND PERCENT COMPOSITION OF FISH IN GILL NETS, ATIKOKAN 1986

Species	Snow Lake	Icy Lake	Abie Lake	Slush Lake	Moose Lake	Marmion Lake South	Marmion Lake Central [1]	Marmion Lake North [1]	Anderson Dam	Lower Seine [1]	Total
Cisco		5(8.9)	13(30.9)	7(35.0)	2(18.2)	38(32.5)	201(38.8)	211(66.8)	11(13.8)	276(48.3)	764(41.1)
White Sucker	22(59.5)	13(23.2)	7(16.7)	5(25.0)		15(12.8)	16(3.1)	16(5.1)	26(32.5)	15(2.6)	219(11.8)
Northern Pike	1(2.7)	10(17.9)	10(23.8)	7(35.0)	5(45.5)	5(4.3)	49(9.5)	14(4.4)	21(26.3)	18(3.2)	140(7.5)
Lake Whitefish	2(5.4)	11(19.6)	10(23.8)	1(5.0)	4(36.4)	51(43.6)	124(23.9)	59(18.7)	11(13.8)	209(36.6)	482(25.9)
Yellow Perch	12(32.4)	11(19.6)				1(0.9)			7(8.8)	5(0.9)	45(2.4)
Walleye		6(10.7)	2(4.8)			7(6.0)	122(23.6)	10(3.2)	4(5.0)	43(7.5)	194(10.4)
Burbot							6(1.2)	6(1.9)		5(0.9)	17(0.9)
All Species	37	56	42	20	11	117	518	316	80	571	1,861
Catch per 2-hour Set	2.6	3.8	3.1	1.4	0.8	8.9	3.9	2.5	5.8	4.0	3.7

1 24 hour sets (approx.)

(C98)

TABLE 4.2-2
COMPARISON OF THE CATCH PER 2-HOUR SET IN GILL NETS SET FOR A NOMINAL 2-HOUR OR 24-HOUR PERIOD

Species	Location	2-Hour Sets[1] (1982-1985)	24-Hour Sets (1986)
Cisco	MC	1.0 (0.4-1.5)	1.5
	MN	1.3 (0.5-1.7)	1.7
	LS	0.5 (0.3-0.7)	1.9
	$\bar{x}$	0.9 (0.7-1.3)	1.7
Lake Whitefish	MC	1.0 (0.0-1.9)	0.9
	MN	0.2 (0.0-0.3)	0.5
	LS	1.1 (0.4-1.4)	1.5
	$\bar{x}$	0.8 (0.5-1.0)	1.0
White Sucker	MC	1.5 (0.5-2.5)	0.1
	MN	1.1 (0.0-1.8)	0.1
	LS	0.3 (0.0-0.4)	0.1
	$\bar{x}$	1.0 (0.5-1.4)	0.1
Northern Pike	MC	0.4 (0.0-0.9)	0.4
	MN	0.4 (0.0-0.6)	0.1
	LS	0.2 (0.0-0.4)	0.1
	$\bar{x}$	0.3 (0.2-0.6)	0.2
Walleye	MC	1.0 (0.0-2.2)	0.9
	MN	0.5 (0.0-0.7)	0.1
	LS	0.7 (0.5-0.9)	0.3
	$\bar{x}$	0.7 (0.3-1.0)	0.4
All Species	MC	5.0 (2.4-6.9)	3.9
	MN	3.3 (2.3-4.5)	2.5
	LS	2.7 (2.1-3.1)	4.0
	$\bar{x}$	3.7 (2.7-4.7)	3.5

1 mean (range)

MC - Marmion Central
MN - Marmion North
LS - Lower Seine

(C98)

patterns among the species rather than a real change in abundance in 1986. The catch per unit effort of all species combined in the 24-hr sets was remarkably similar to that in the 2-hr sets.

The catch per 2-hr set in 1986 ranged from 0.8 in Moose Lake to 8.9 at Marmion South (Table 4.2-1). The locations where the two highest CUE's (Marmion South and Anderson Dam) and the four lowest CUE's (Moose, Slush, Marmion North and Slush) were identical to those during preoperational studies (OHRD Report No 85-333-K).

The temporal variability in the catches of the principal species caught in gill nets is illustrated in Figure 4.2-1. Monthly catches of walleye, northern pike, lake whitefish, cisco and white sucker are presented by location in Figures 4.2.-2 to 4.2-6. Cisco and whitefish were most abundant in catches during the summer (June through August) while northern pike and walleye were least abundant during the summer months. There was no trend apparent for white sucker. The greater susceptibility of the coregonids to the gill nets during the summer is likely related to their distribution relative to the thermocline. During the summer the nets are generally set below the thermocline and above the depth of reduced oxygen concentrations (<2ppm). Due to their preference for cool temperatures, the coregonids should be concentrated in the same strata in which the nets are set. During the spring and fall, however, when temperatures do not vary substantially with depth and the entire water column is well oxygenated, the coregonids are likely distributed throughout the water column and consequently catches would be smaller.

A comparison of the gill net catches from 1986 with those from 1982 through 1985 (Table 4.2-3, Figures 4.2-7 to 4.2-11) indicated that the contribution of lake whitefish to the catch in 1986 was above the range of values previously reported and that of white sucker and walleye were below the range of values previously reported. On a catch per unit effort basis the CUE of northern pike and walleye were below previously reported values.

Analysis of variance was employed to identify significant differences among locations, years and seasons (May, August and October) for the principal species. The results of this analysis are summarized in Table 4.2-4. For lake whitefish only one individual was collected from Snow and Slush Lakes over the five years of study and these locations were excluded from the analysis. Similarly, no walleye were collected from Snow, Slush and Moose Lakes and these locations were excluded.

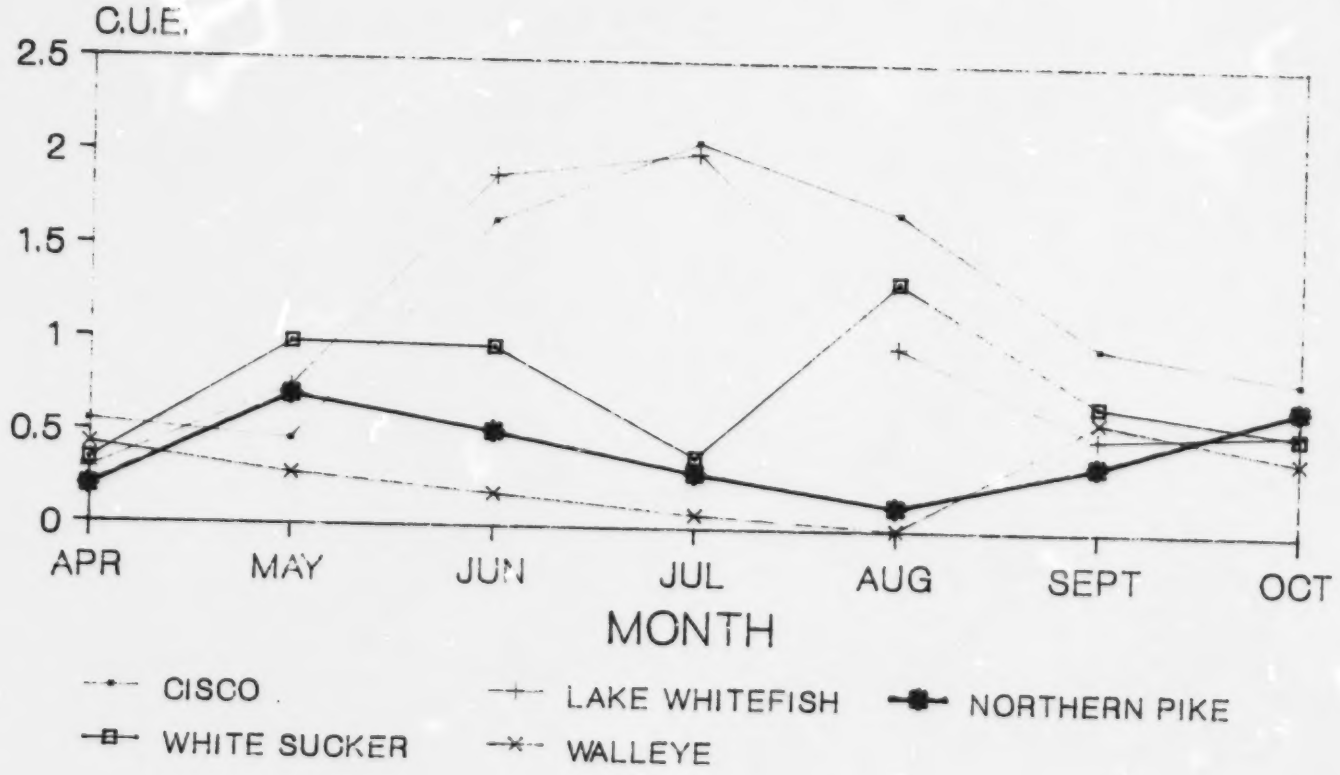
Location was a significant factor for lake whitefish, northern pike, walleye and white sucker and season was significant for walleye. A significant interaction between season and location for cisco suggests that differences among locations were dependent upon the season. Multiple range tests (Table 4.2-5) indicate those locations which are not significantly different. Generally, catches of whitefish, pike, walleye and sucker at Anderson Dam were significantly greater than many or all of the remaining sites. The catch of walleye was significantly lower in August than in May and October.

4.2.2 Beach Seines

A total of 44,344 fish were collected in 300 beach seine hauls during 1986 (Appendix 5). Yellow perch which comprised 46 percent of the catch was the most commonly collected species (Table 4.2-6). Blacknose shiner (22 %) mimic shiner (15 %) and young-of-the-year white sucker (10 %) were also relatively abundant.

Yellow perch was the most common species at Snow, Icy and Moose Lakes and in Marmion Lake at Marmion South and Marmion North. In Abie and Slush Lakes, blacknose shiner was the most commonly collected species while pumpkinseed, white sucker and mimic shiner were the most

FIGURE 4.2-1
MONTHLY CATCH PER 2-HOUR GILLNET SET
1986



All Locations

FIGURE 4.2-2
MONTHLY CATCH OF WALLEYE
PER 2-HOUR GILLNET SET 1986

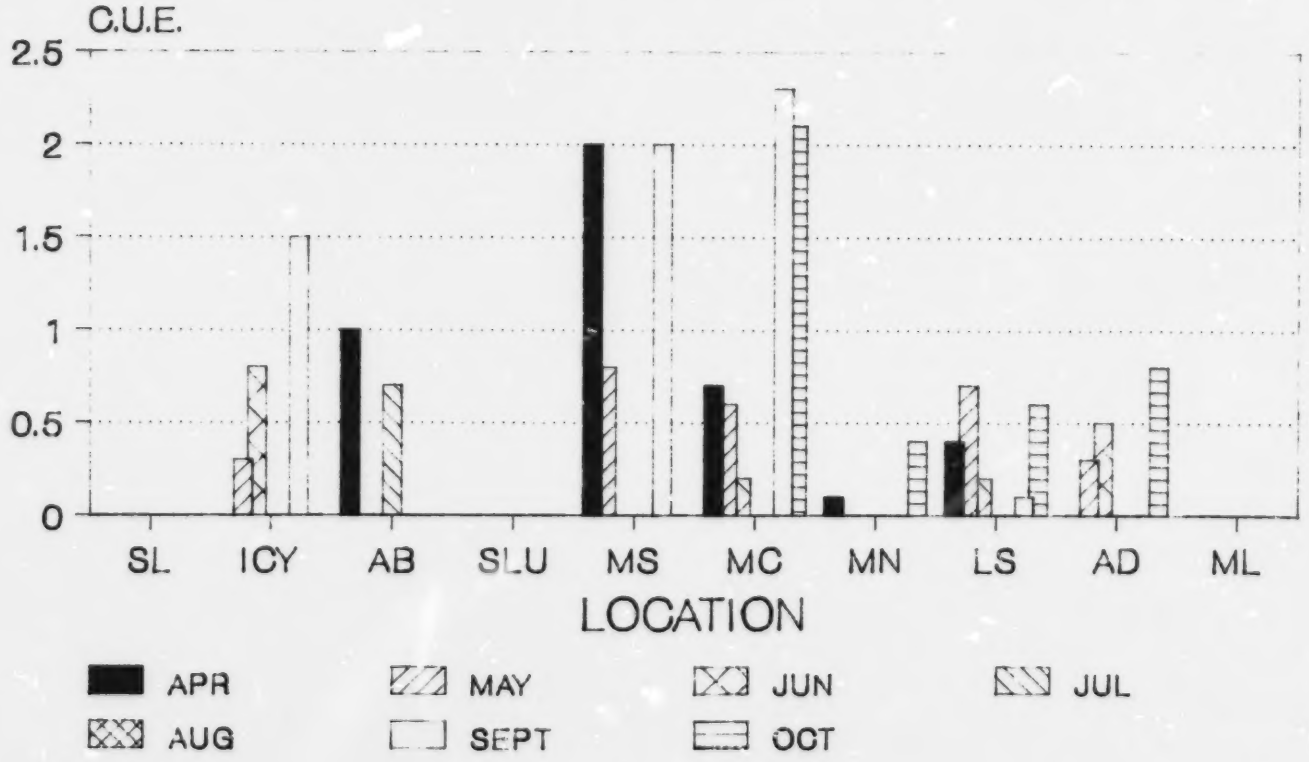


FIGURE 4.2-3
MONTHLY CATCH OF NORTHERN PIKE PER 2-HOUR GILLNET SET 1986

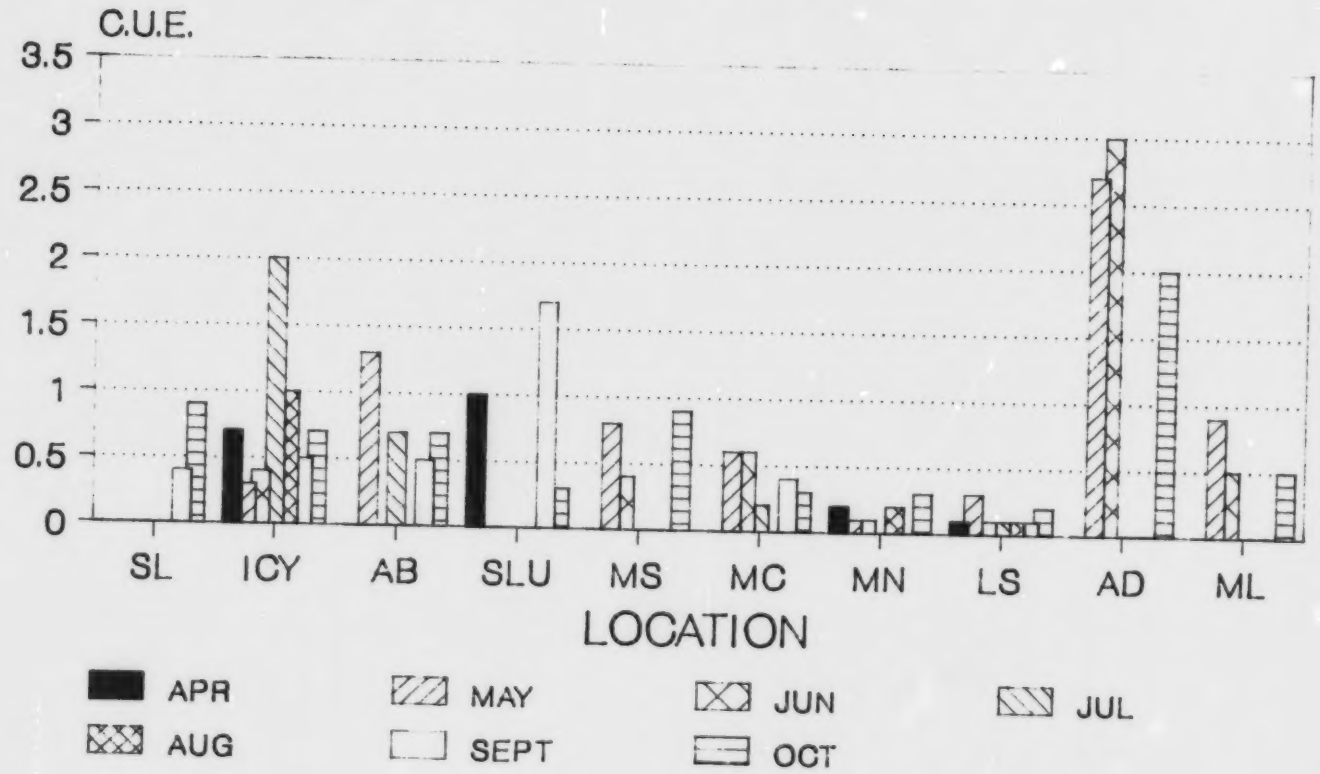


FIGURE 4.2-4
MONTHLY CATCH OF LAKE WHITEFISH PER 2-HOUR GILLNET SET 1986

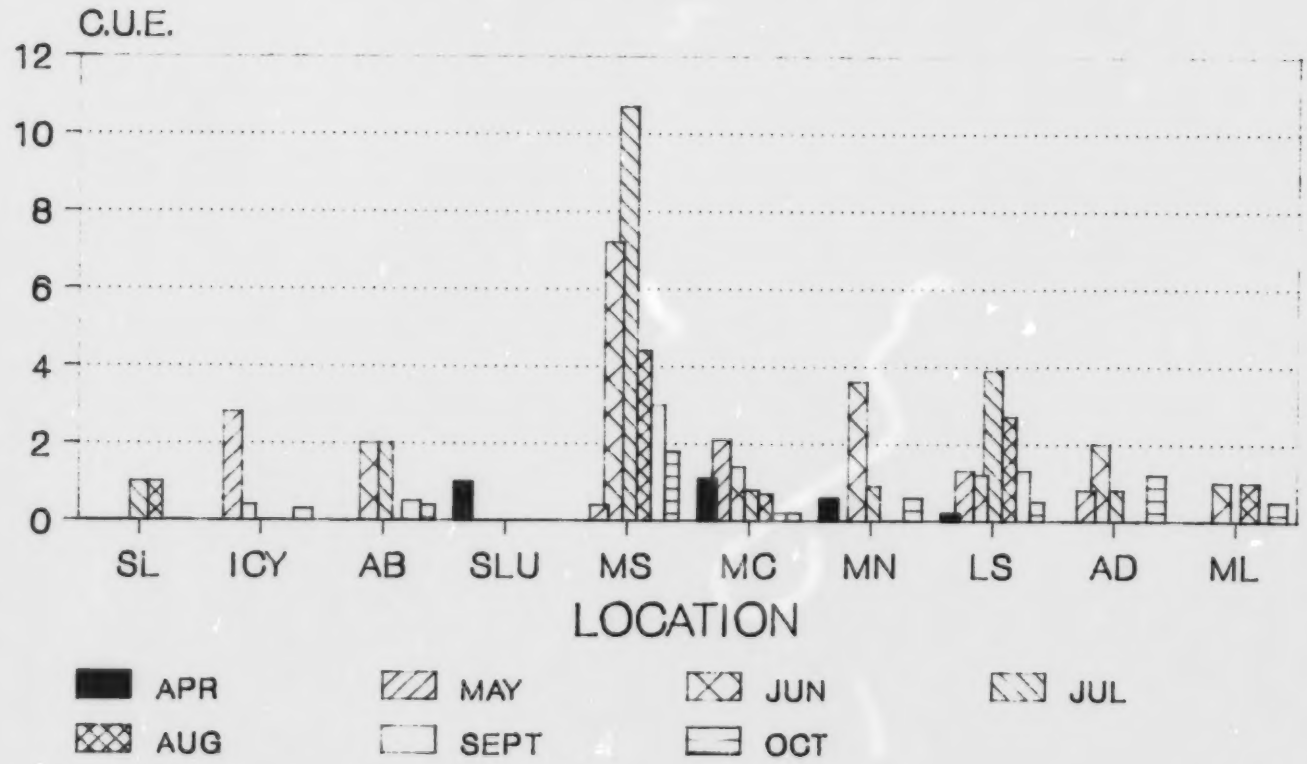


FIGURE 4.2-5
MONTHLY CATCH OF CISCO PER 2-HOUR GILLNET SET 1986

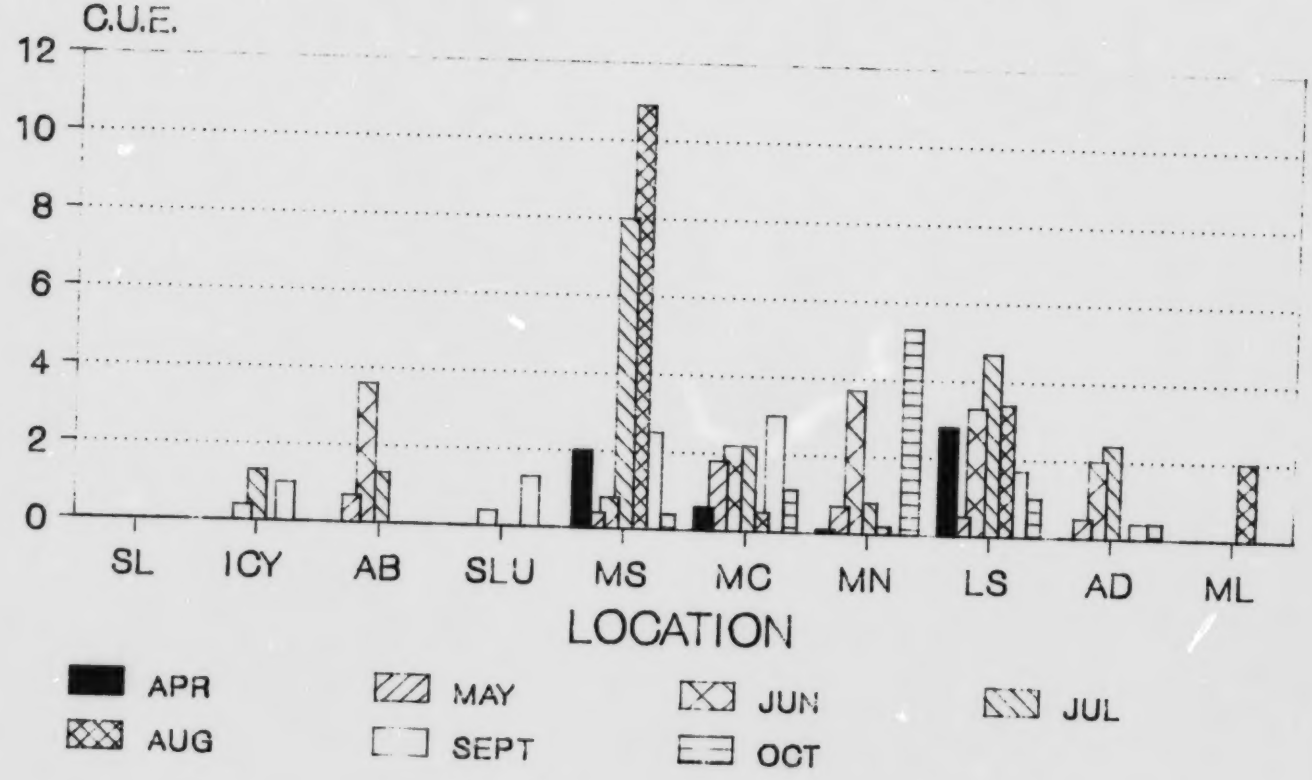


FIGURE 4.2-6
MONTHLY CATCH OF WHITE SUCKER
PER 2-HOUR GILLNET SET 1986

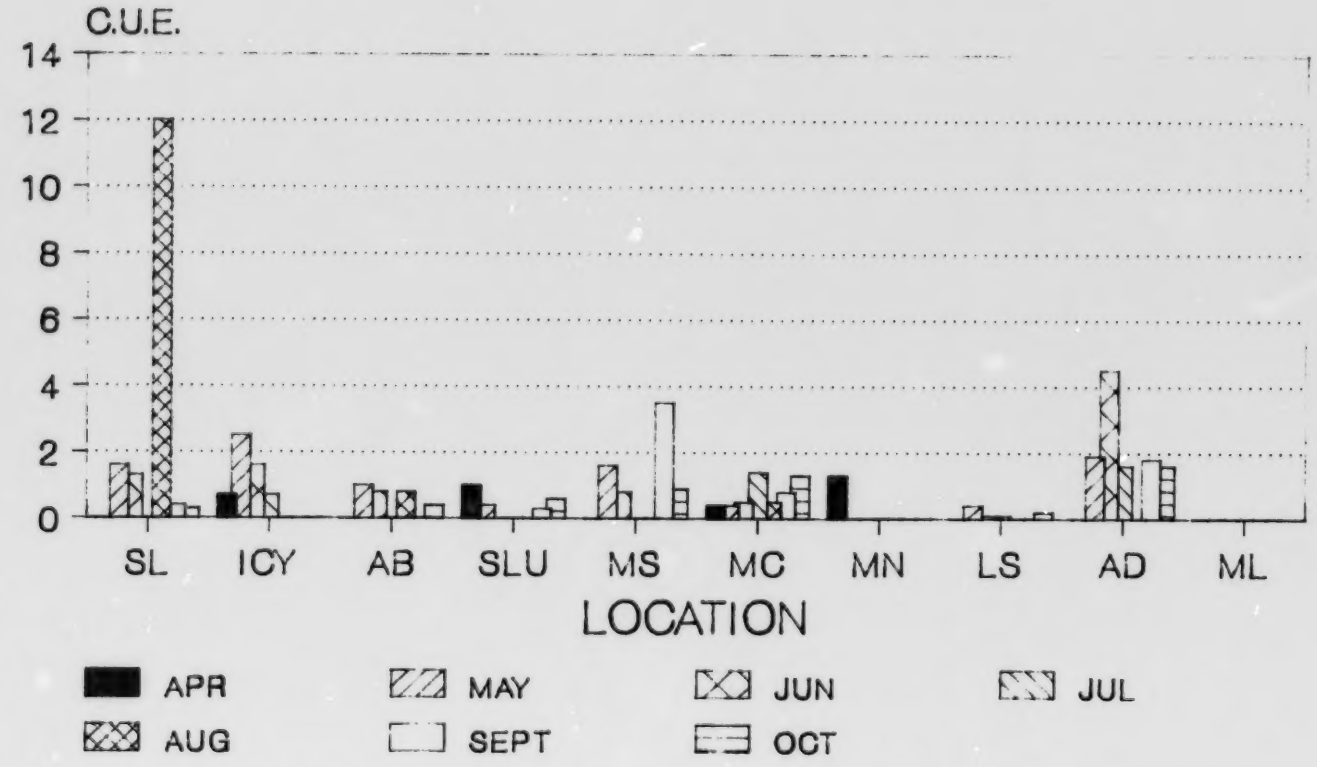


TABLE 4.2-3

COMPARISON OF GILL NET CATCHES 1982-1986

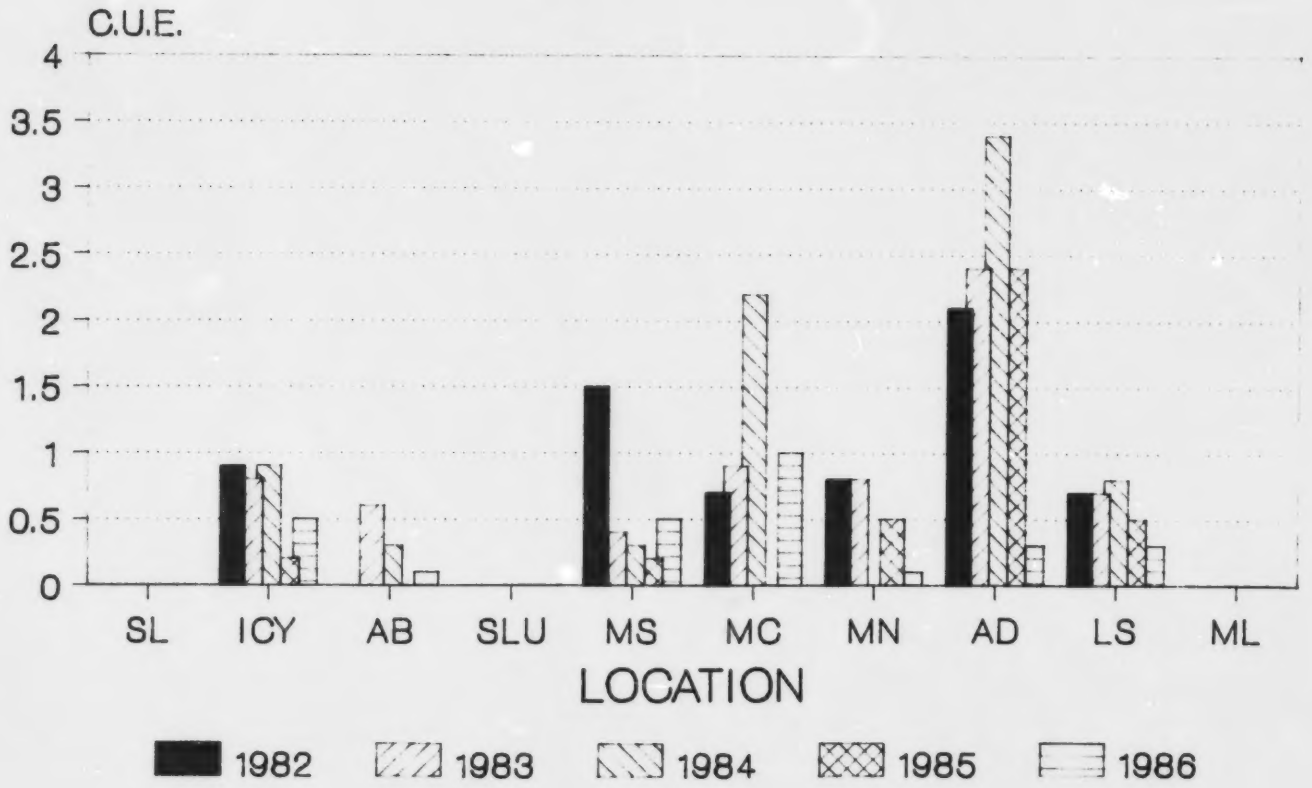
Species	1982	1983	1984	1985	1986[2]
Cisco	20(1.2)[1]	31(1.6)	19(0.6)	33(1.3)	29(1.1)
White Sucker	26(1.6)	23(1.2)	21(0.7)	20(0.8)	18(0.7)
Northern Pike	18(1.1)	12(0.6)	19(0.6)	16(0.6)	13(0.5)
Lake Whitefish	17(1.1)	16(0.8)	13(0.4)	14(0.5)	26(1.0)
Walleye	12(0.7)	15(0.8)	23(0.8)	10(0.4)	8(0.3)
Yellow Perch	6(0.4)	2(0.1)	4(0.1)	7(0.3)	5(0.2)
Burbot	<1(0.1)	<1(0.1)	0(0.0)	0(0.0)	<1(0.0)
Pumpkinseed	0(0.0)	0(0.0)	0(0.0)	<1(0.1)	0(0.0)
Total Catch	344	644	98	184	1,861
Catch per 2 hr Set (May, Aug and Oct)	6.2 (6.2)	5.2 (4.6)	3.2 (3.2)	4.0 (4.0)	3.8 (3.2)

1 Percent Composition and catch per 2-hour set.

2 Percent Composition based on catch per 2-hour set.

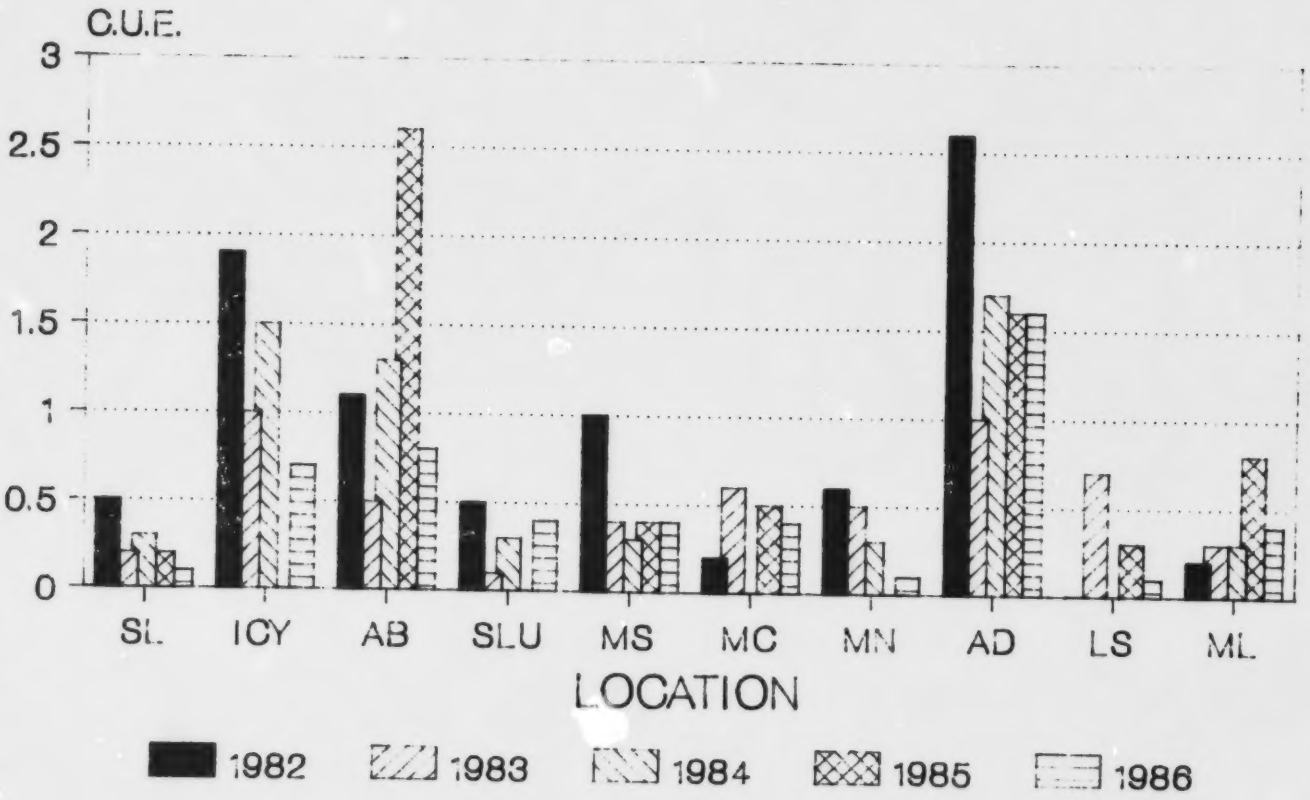
(C98)

FIGURE 4.2-7
ANNUAL CATCH OF WALLEYE PER 2-HOUR GILLNET SET 1982-1986



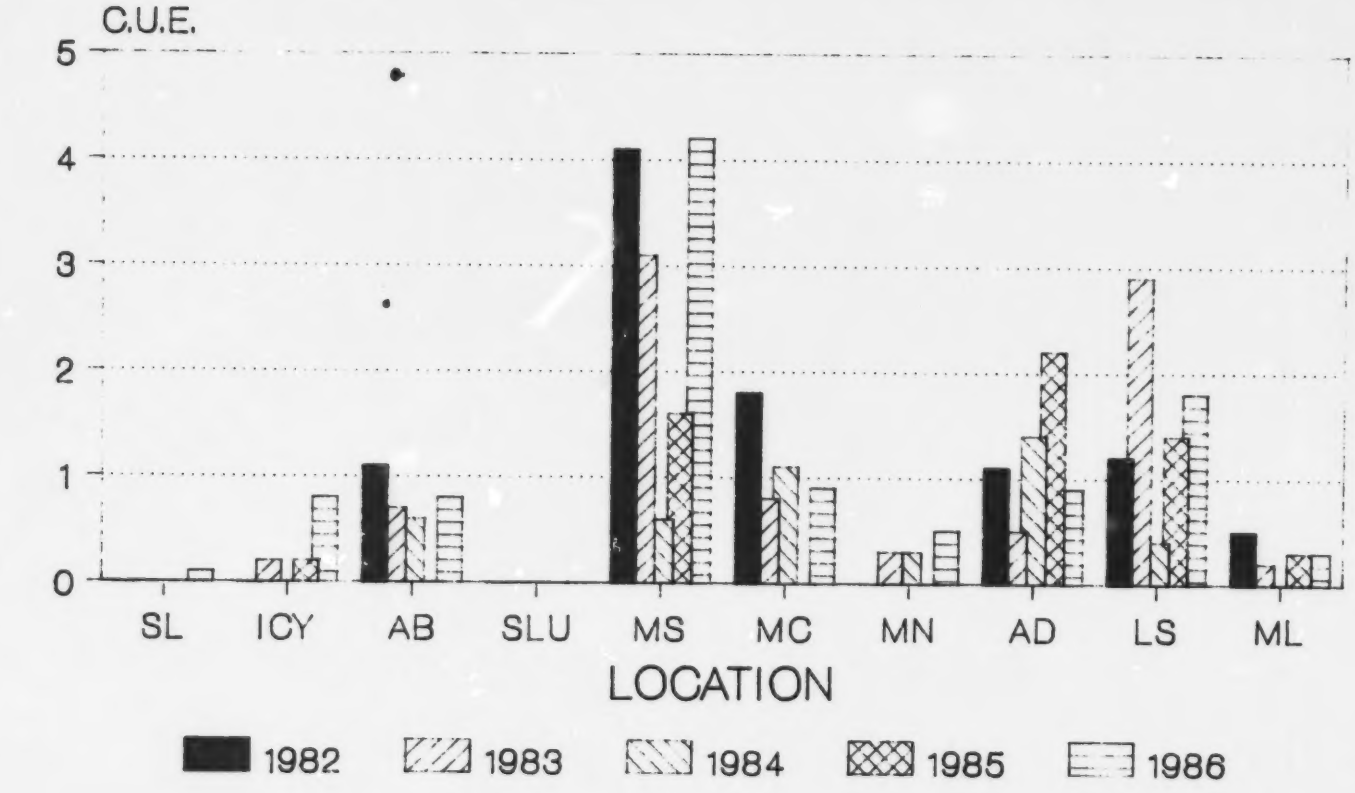
May, August, October

FIGURE 4.2-8
ANNUAL CATCH OF NORTHERN PIKE PER 2-HOUR GILLNET SET 1982-1986



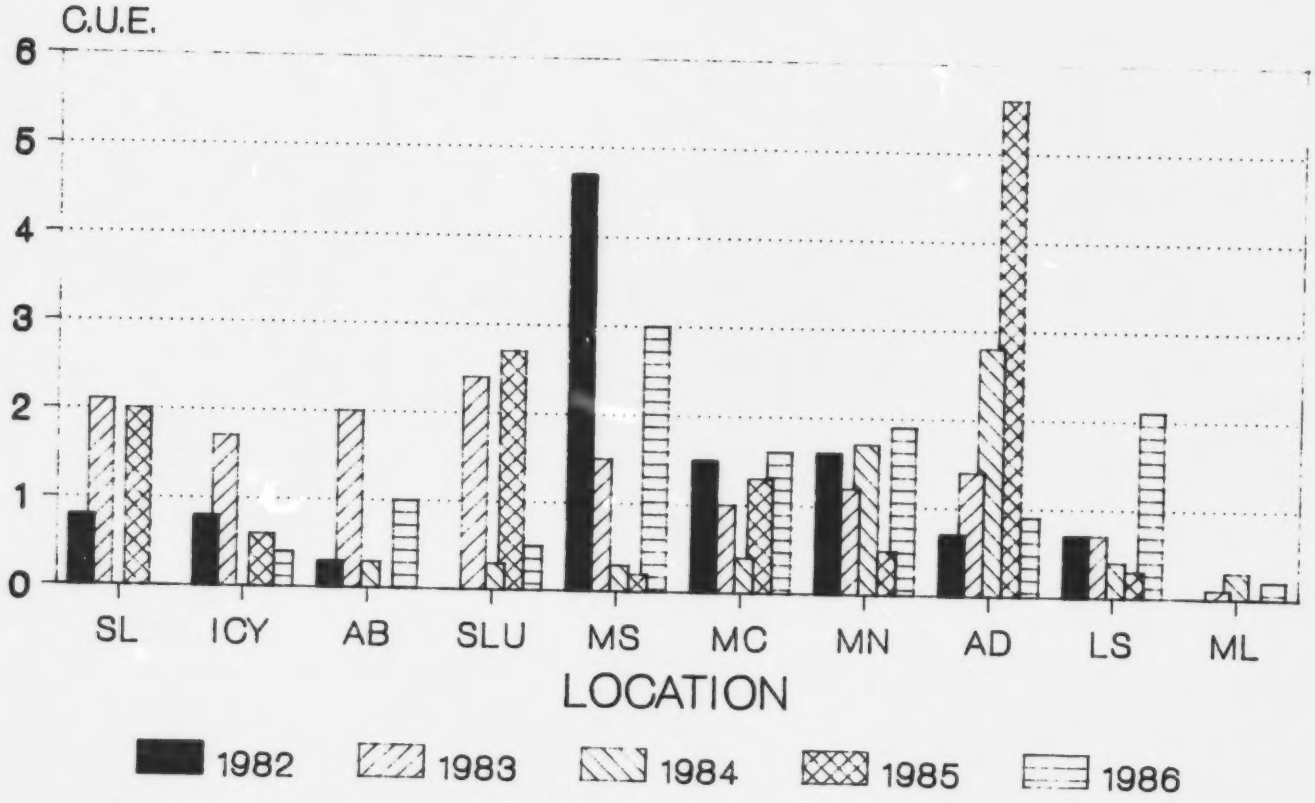
May, August, October

FIGURE 4.2-9
ANNUAL CATCH OF LAKE WHITEFISH PER 2-HOUR GILLNET SET 1982-1986



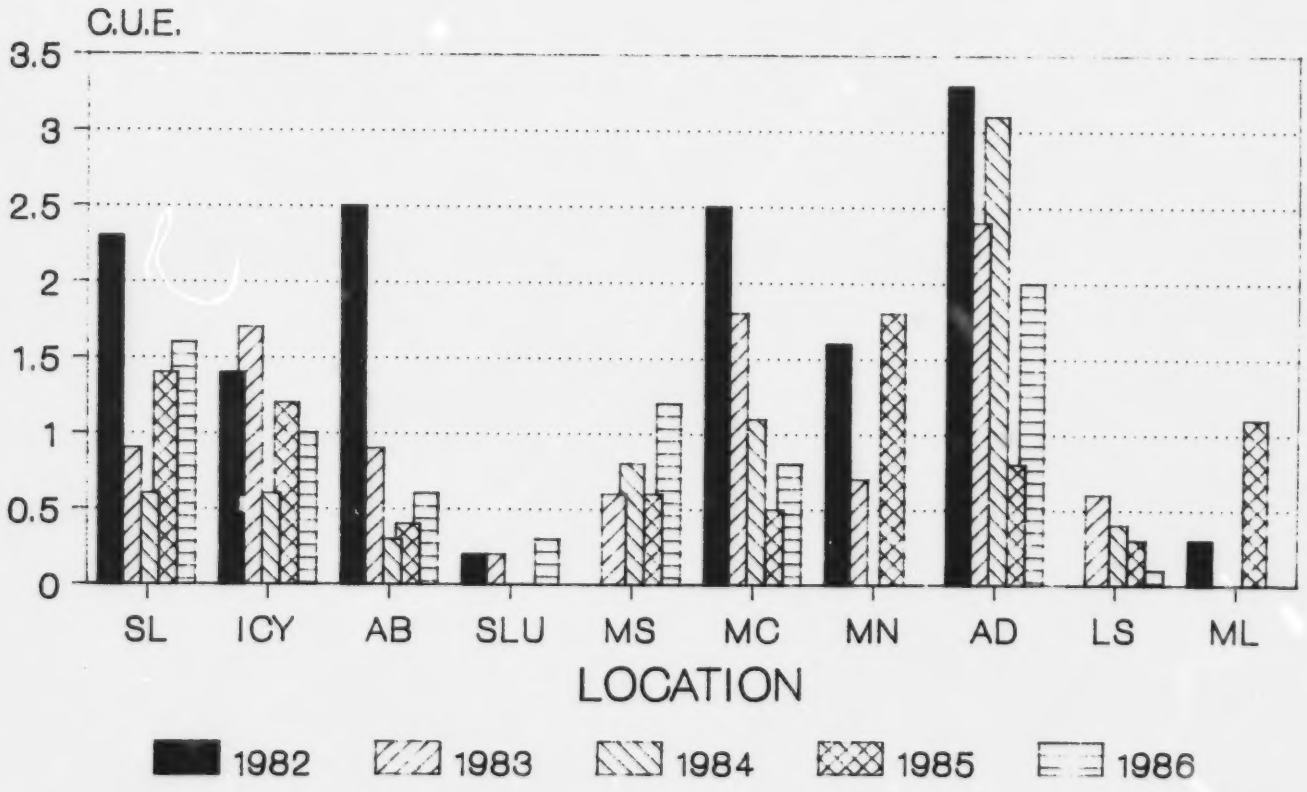
May, August, October

FIGURE 4.2-10
ANNUAL CATCH OF CISCO PER 2-HOUR GILLNET SET 1982-1986



May, August, October

FIGURE 4.2-11
ANNUAL CATCH OF WHITE SUCKER PER 2-HOUR GILLNET SET 1982-1986



May, August, October

TABLE 4.2-4

SUMMARY OF 2-WAY ANALYSIS OF VARIANCE FOR FISH COLLECTED IN GILL NETS

Source of Variation	Cisco	Lake Whitefish[1]	Northern Pike	Walleye[2]	White Sucker
Year	NS	NS	NS	NS	NS
Season	NS	NS	NS	<.001	NS
Location	NS	<.001	<.001	<.001	<.01
Year and Season	NS	NS	NS	NS	NS
Year and Location	NS	NS	NS	NS	NS
Season and Location	<.001	NS	NS	NS	NS

1 Excluding Snow and Slush Lakes

2 Excluding Snow, Slush and Moose Lakes

NS - not significant $p>0.05$

TABLE 4.2-5

RESULTS OF DUNCAN'S MULTIPLE RANGE TESTS OF SIGNIFICANT EFFECTS IN ANOVA OF GILL NET CATCH

Lake Whitefish

Location	MN	Moose	Icy	Abie	MC	LS	AD
Mean	0.11	0.27	0.27	0.39	0.87	1.37	1.53

Northern Pike

Location	LS	MC	Snow	Slush	MN	MS	Moose	Icy	Abie	AD
Mean	0.24	0.26	0.27	0.35	0.44	0.51	0.53	1.53	1.64	1.91

Walleye

Location	Abie	MS	MN	Icy	LS	MC	AD
Mean	0.17	0.59	0.66	0.72	0.79	0.85	2.44

Month	August	May	October
Mean	0.24	0.95	1.47

White Sucker

Location	Slush	Moose	LS	MS	Abie	MN	MC	Icy	Snow	AD
Mean	0.20	0.33	0.37	0.67	0.95	0.97	1.25	1.30	2.09	2.20

Note: Horizontal lines indicate homogeneous groups
MN - Marmion North, MC - Marmion Central, MS - Marmion South
AD - Anderson Dam, LS - Lower Seine

(C98)

TABLE 4.2-6

CATCH AND PERCENT COMPOSITION OF FISH COLLECTED IN BEACH SEINES - 1986

Species	Snow L.	Icy L.	Abie L.	Slush L.	Marmion South	Marmion Central	Marmion North	Anderson Dam	Lower Seine	Moose L.	Total	Catch Per Seine
Yellow Perch	7,397(89.9)	3,059(63.3)	384(8.8)	1,504(30.8)	2,161(51.9)	217(12.9)	4,220(74.1)	95(2.0)	186(5.2)	1,306(62.6)	20,529(46.2)	68.4
Blacknose Shiner	488(5.9)	764(15.8)	2,759(63.3)	3,357(68.7)	1,491(35.8)	312(18.5)	139(2.4)	85(1.8)	287(8.0)	84(4.0)	9,766(22.0)	32.6
Mimic Shiner	185(2.2)	42(0.9)	738(16.9)	1(0.0)	270(6.5)	73(4.3)	764(13.4)	1,570(32.4)	2,620(72.7)	409(19.6)	6,672(15.0)	22.2
White Sucker	24(0.3)	289(6.0)	161(3.7)	-	112(2.7)	262(15.5)	373(6.5)	2,974(61.5)	201(5.6)	151(7.2)	4,547(10.3)	15.2
Pumpkinseed	2(0.0)	9(0.2)	8(0.2)	-	5(0.1)	750(44.4)	1(0.0)	-	1(0.0)	-	776(1.7)	2.6
Iowa Darter	56(0.7)	157(3.3)	58(1.3)	22(0.5)	49(1.2)	23(1.4)	43(0.8)	19(0.4)	254(7.1)	57(2.7)	738(1.7)	2.5
Logperch	-	379(7.8)	64(1.5)	-	2(0.0)	4(0.2)	32(0.6)	88(1.8)	9(0.2)	6(0.3)	584(1.3)	2.0
Spottail Shiner	9(0.1)	105(2.2)	127(2.9)	-	44(1.1)	7(0.4)	102(1.8)	4(0.1)	18(0.5)	47(2.3)	466(1.0)	1.6
Golden Shiner	67(0.8)	6(0.1)	16(0.4)	-	-	9(0.5)	1(0.0)	1(0.0)	7(0.2)	3(0.1)	110(0.2)	0.4
Fathead Minnow	2(0.0)	5(0.1)	-	-	-	30(1.8)	16(0.3)	-	19(0.5)	-	72(0.2)	0.2
Walleye	-	4(0.1)	-	-	30(0.7)	-	3(0.1)	-	-	-	37(0.1)	0.1
Lake Chub	-	-	31(0.7)	-	-	-	-	-	-	-	31(0.1)	0.1
Cisco	1(0.0)	-	2(0.0)	-	-	-	-	-	-	10(0.5)	13(0.0)	0.0
Lake Whitefish	-	-	-	-	-	-	-	-	-	12(0.6)	12(0.0)	0.0
Slimy Sculpin	-	6(0.1)	1(0.0)	-	-	1(0.1)	1(0.0)	-	-	-	9(0.0)	0.0
Longnose Dace	-	3(0.1)	6(0.1)	-	-	-	-	-	-	-	9(0.0)	0.0
Bluntnose Minnow	-	-	-	-	-	-	3(0.1)	-	-	-	3(0.0)	0.0
Redbelly Dace	-	1(0.0)	1(0.0)	-	-	-	-	-	-	-	2(0.0)	0.0
Cyprinidae	-	-	-	-	-	-	-	2(0.0)	-	-	2(0.0)	0.0
Northern Pike	-	-	-	1(0.0)	-	-	-	-	-	-	1(0.0)	0.0
Trout-Perch	-	-	-	-	-	-	-	1(0.0)	-	-	1(0.0)	0.0
Total	8,231	4,829	4,356	4,885	4,164	1,688	5,698	4,839	3,602	2,085	44,377	
Catch per Seine	274.4	161.0	145.2	162.8	138.8	56.3	189.9	161.3	120.1	69.5	147.9	

(C98)

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frequently collected species at Marmion Central, Anderson Dam and Lower Seine, respectively. Catches ranged from 56 fish per seine haul at Marmion Central to 274 fish per haul in Snow Lake.

The composition of the beach seine catch was very similar to that of the preoperational study (OHRD Report No 86-38-K) with the four most abundant species in 1986 identical to those during the 1981 to 1983 period. However, the composition of fish in beach seines at specific sites did differ from that in preoperational studies. Most notably, the relative contribution of yellow perch increased substantially in beach seines in Snow and Icy Lakes. During the preoperational phase, yellow perch made up approximately 13 % of the beach seine catch (23 per haul) in Snow and Icy Lakes while in 1986 yellow perch contributed to more than 60 % of the catch (174 per haul) while the contribution of mimic shiner dropped from 13 to 26 % in the preoperational phase (30 per haul) to 1 to 2 % in 1986 (4 per haul). Similarly, in Marmion Lake the contribution of young-of-the-year white sucker increased from an average 2% of the catch in the preoperational phase (1 per haul) to 18% in 1986 (26 per haul).

Trends in the seasonal abundance of the principal species caught in beach seines (Table 4.2-7) were readily apparent for blacknose shiner, mimic shiner and white sucker. Blacknose shiner were most abundant in the catch late May into July while mimic shiner were most common June through August. Young-of-the-year white sucker were most abundant in July. The trends in relative abundance of these three species appear to relate to the abundance of young-of-the-year fish in nearshore waters and their susceptibility to capture in the collection gear during the late spring and summer.

A comparison of the annual beach seine catches for 1981 through 1986 are presented in Table 4.2-8. The total catch per haul in 1986 exceeded that of all other years based on the total sampling season and based on May, August and October, only. The pattern of relatively high catches in May, August and October during years when sampling was conducted at least monthly (1981, 83 and 86) and relatively low catches during years when samples were collected in May, August and October, only (1982, 84 and 85) continued in 1986. The only plausible explanation for this pattern is that familiarity with the site influences the manner in which the beach seines are deployed in order to be most effective (ie. catch the most fish).

With the exception of yellow perch, the per cent composition and catch per haul of each species in 1986 fell within or very close to the range of values reported from 1981 through 1985. The relative and actual abundance of yellow perch, however, exceeded the range of values previously reported. As discussed above, the increase in yellow perch abundance is attributable to the substantial increases in yellow perch in Snow and Icy Lakes.

Analysis of variance was employed to determine significant differences in the beach seine catches of the principal species among locations, seasons (May, August and October) and years. The results of these analyses are summarized in Table 4.2-9. Season was a significant factor for each species analyzed (yellow perch, blacknose shiner, mimic shiner and Iowa darter); year was significant for each species except Iowa darter, and location was significant for Iowa darter, only. There were significant interaction terms for year x season for all species except Iowa darter and for season x location for mimic shiner.

Duncan's multiple range tests were conducted for the significant factors identified in the ANOVA (Table 4.2-10). As discussed above the most obvious differences among years were those between the years sampled monthly (1981, 83 and 86) and those sampled seasonally (1982, 84 and 85). For those species whose catches varied significantly among seasons, yellow perch were significantly more common in the catch in August than October, blacknose shiner in May

TABLE 4.2-7

TEMPORAL VARIABILITY IN THE CATCH PER BEACH SEINE
ATIKOKAN 1986

Species	Early May	Late May	Early June	Late June	July	August	Early Sept.	Late Sept.	Early Oct.	Late Oct.
Yellow Perch	7.3	45.2	57.6	36.6	113.6	50.7	183.0	31.7	69.5	89.1
Blacknose Shiner	12.7	109.6	42.1	101.5	28.1	3.4	18.8	3.7	1.7	4.0
Mimic Shiner	5.6	2.5	99.7	25.9	57.3	29.5	1.3	0.4	0.0	0.1
White Sucker	0.2	0.1	3.1	4.1	128.8	8.1	3.6	1.1	1.8	0.7
Pumpkinseed	0.0	0.1	0.0	0.0	0.1	0.0	23.8	1.4	0.4	0.1
Iowa Darter	9.2	2.0	1.2	1.9	1.6	2.0	2.2	1.1	2.0	1.3
Logperch	0.5	1.8	8.7	2.9	1.2	2.4	1.5	0.4	0.0	0.0
Spottail Shiner	1.9	0.9	1.0	2.9	0.1	4.8	1.6	1.2	1.4	0.1
Others	0.4	0.8	2.3	1.1	0.6	0.2	2.8	0.5	0.2	0.3
All Species	37.8	163.0	215.7	176.9	331.4	101.1	238.6	41.5	77.0	95.7

(C98)

TABLE 4.2-8

COMPARISON OF BEACH SEINE CATCHES 1981-1986

Species	1981	1982	1983	1984	1985	1986
Blacknose Shiner	30 (41) [1]	30 (7)	31 (21)	18 (3)	6 (1)	22 (33)
Mimic Shiner	21 (29)	20 (5)	37 (25)	7 (1)	24 (5)	15 (22)
Yellow Perch	28 (38)	13 (3)	15 (10)	8 (1)	37 (7)	46 (68)
Iowa Darter	2 (3)	9 (2)	4 (3)	38 (5)	23 (5)	2 (3)
White Sucker	10 (14)	3 (<1)	2 (1)	7 (1)	12 (2)	10 (15)
Pumpkinseed	1 (1)	19 (5)	2 (1)	2 (<1)	0 (<1)	2 (3)
Spottail Shiner	1 (1)	2 (<1)	2 (1)	15 (2)	5 (1)	1 (2)
Logperch	1 (1)	2 (<1)	2 (1)	3 (<1)	4 (<1)	1 (2)
Golden Shiner	4 (5)	2 (<1)	1 (<1)	1 (<1)	0 (<1)	0 (<1)
Cyprinidae	0 (<1)	-	2 (1)	-	-	0 (<1)
Fathead Minnow	0 (<1)	-	0 (<1)	1 (<1)	-	0 (<1)
Ninespine Stickleback	0 (<1)	-	0 (<1)	0 (<1)	-	-
Slimy Sculpin	1 (1)	1 (<1)	0 (<1)	0 (<1)	0 (<1)	0 (<1)
Lake Chub	1 (1)	-	0 (<1)	0 (<1)	0 (<1)	0 (<1)
Lake Whitefish	0 (<1)	-	-	-	-	0 (<1)
Burbot	0 (<1)	-	0 (<1)	-	-	-
Walleye	0 (<1)	-	0 (<1)	-	0 (<1)	0 (<1)
Bluntnose Minnow	0 (<1)	-	-	-	-	0 (<1)
Finescale Dace	0 (<1)	-	-	-	-	-
Emerald Shiner	0 (<1)	-	-	-	-	-
Trout-Perch	0 (<1)	-	-	-	-	0 (<1)
Redbelly Dace	0 (<1)	-	0 (<1)	-	-	0 (<1)
Cisco	0 (<1)	-	-	-	-	0 (<1)
Northern Pike	0 (<1)	0 (<1)	0 (<1)	-	0 (<1)	0 (<1)
Longnose Dace	-	-	0 (<1)	-	-	0 (<1)
Central Mudminnow	-	-	0 (<1)	-	-	-
Notropis sp	-	-	0 (<1)	-	-	-
Total Catch	31,131	1,902	14,342	1,285	1,872	44,377
Catch Per Haul	137 (87) [2]	24 (24)	68 (54)	14 (14)	20 (20)	148 (96)

1 Percent composition, and catch per haul,
2 May, August and October only,
0 = present <0.5% contribution,
- = absent.

(C98)

TABLE 4.2-9

SUMMARY OF 2-WAY ANALYSIS OF VARIANCE FOR FISH COLLECTED IN BEACH SEINE
(LOG TRANSFORMED DATA)

Source of Variation	Yellow Perch	Blacknose Shiner	Mimic Shiner	Iowa Darter
Year	<.001	<.001	<.01	NS
Season	<.01	<.001	<.001	<.05
Location	NS	NS	NS	<.001
Year and Season	<.05	<.001	<.05	NS
Year and Location	NS	NS	NS	NS
Season and Location	NS	NS	<.001	NS

NS - Not Significant p>0.05

(C98)

TABLE 4.2-10

RESULTS OF DUNCAN'S MULTIPLE RANGE TESTS OF SIGNIFICANT EFFECTS IN ANOVA OF BEACH SEINE CATCH

Yellow Perch

Year	1984	1982	1985	1983	1981	1986
Mean[1]	0.5	0.6	1.5	2.6	7.4	11.4

Season	October	May	August
Mean	1.6	2.3	4.7

Blacknose Shiner

Year	1985	1984	1982	1986	1983	1981
Mean	0.5	0.6	1.1	3.1	3.2	4.0

Season	October	May	August
Mean	0.6	1.8	3.6

Mimic Shiner

Year	1984	1982	1985	1983	1986	1981
Mean	0.3	1.0	1.4	1.7	1.8	4.6

Season	October	May	August
Mean	0.6	1.0	4.0

Iowa Darter

Location	Slush	MN	MC	AD	Moose	Abie	MS	Icy	LS	Snow
Mean	0.2	0.3	0.4	0.5	0.9	1.0	1.2	1.4	3.5	3.9

Season	October	May	May
Mean	0.6	1.4	1.4

Note: Horizontal lines indicate homogeneous groups
MN - Marmion North, MC - Marmion Central, AD - Anderson Dam
MS - Marmion South, LS - Lower Seine
1 geometric mean

and August than in October, mimic shiner in August than in May and October, and Iowa darter in May and August than in October. For Iowa darter the catch in Snow Lake was significantly greater than all of the remaining locations except Lower Seine.

4.2.3 Larval Fish

Tows:

The catch of larval fish and eggs in tow nets is listed in Appendix 6. Four taxa made up more than 95% of the 3 123 larval fish collected in tow nets (Table 4.2-11). Yellow perch (34%) was the most commonly collected species overall and at five of the ten basins sampled (Slush Lake, Marmion Central, Marmion North, Anderson Dam and Lower Seine). Pumpkinseed (26%) was the most common species collected in Snow, Icy and Abie Lakes while white sucker (23%) was the most common species at Marmion South. Cyprinids (13%) were the most common larval fish at Marmion South. Compared to the composition of larval tows during preoperational studies (OHRD Report No 86-38-K), the contribution of pumpkinseed and white sucker increased substantially while that of Iowa darter decreased substantially in 1986.

On a catch per tow basis, the majority of locations averaged from approximately eight to sixteen fish per tow. Abie and Moose Lakes, however, averaged 32 and 25 fish per tow, respectively. The catch per tow overall and at most locations was higher in 1986 than during preoperational studies (OHRD Report No 86-38-K).

The catch per tow relative to sampling date averaged over all locations is listed in Table 4.2-12. The temporal distribution of larval abundance compared well with that of preoperational studies (OHRD Report No 86-38-K). Yellow perch were present in the catch on most of the sampling dates peaking in abundance in the first week of June, one week prior to white suckers. Pumpkinseed were only collected during July while cyprinid larvae were not collected prior to June 9. The coregonids, cisco and whitefish, were not collected after May 23.

Drift Nets:

Sets of three plankton nets were set at the downstream end of the outlet channels of the cooling circuit lakes on five occasions between May 8 and 22. The intent of these sets was to collect walleye eggs and emerging larvae. The results of these sets by date are listed in Appendix 7 and summarized in Table 4.2-13. In addition, a 0.5 m larval tow net was set in the Snow Lake outfall and the downstream side of the Spillway Dam on five occasions from April 29 to July 13. The results of these samples are listed by date in Appendix 8 and summarized in Table 4.2-14.

Only one walleye egg and no larvae were collected in the plankton nets. The lone walleye egg was collected at the outflow of Abie Lake where walleye spawning had not been observed in recent years. White sucker eggs comprised the majority of the catch in the plankton nets and were collected at all locations except at the Abie Lake outlet. Two percid larvae (Iowa darter) at the Ski Lake outlet and one unidentifiable larva at the Abie Lake outlet made up the remainder of the catch.

Relatively large numbers of walleye eggs were collected in the larval tow nets set on April 29 at both Snow Lake and at the Spillway Dam. In addition, one walleye larvae was collected at Snow Lake on the same date. White sucker eggs also dominated the catch in the larval tow nets while yellow perch and cyprinid eggs became common as the sampling progressed.

Quantitative comparisons of the catch among locations are not appropriate as accurate estimates

TABLE 4.2-11

NUMBER AND PERCENT COMPOSITION OF THE CATCH IN LARVAL TOW NETS - 1986

	Snow Lake	Icy Lake	Abie Lake	Slush Lake	Marmion South	Marmion Central	Marmion North	Anderson Dam	Lower Seine	Moose Lake	Total
Larvae											
Yellow Perch	152(46.6)	29(11.6)	77(10.1)	78(77.2)	68(22.6)	99(68.3)	154(67.2)	125(79.6)	104(63.0)	188(27.3)	1,074(34.4)
Pumpkinseed	162(49.7)	128(51.4)	331(43.5)	2(2.0)	60(19.9)	17(11.7)	51(22.3)	7(4.5)	38(23.0)	4(0.6)	800(25.6)
White Sucker	0	25(10.0)	188(24.7)	0	74(24.6)	12(8.3)	2(0.9)	2(1.3)	6(3.6)	420(61.0)	729(23.3)
Cyprinidae	11(3.4)	52(20.9)	151(19.8)	8(8.0)	77(25.6)	16(11.0)	17(7.4)	18(11.5)	15(9.1)	32(4.6)	397(12.7)
Logperch	0	13(5.2)	12(1.6)	0	16(5.3)	0	1(0.4)	0	0	7(1.0)	49(1.6)
Cisco	0	0	0	0	0	0	0	1(0.6)	0	35(5.1)	36(1.2)
Lake Whitefish	0	0	0	7(7.0)	1(0.3)	1(0.7)	0	2(1.3)	0	2(0.3)	13(0.4)
Burbot	0	0	0	0	3(1.0)	0	0	1(0.6)	2(1.2)	0	6(0.2)
Golden Shiner	0	0	0	0	1(0.3)	0	4(1.7)	0	0	0	5(0.2)
Walleye	0	1(0.4)	0	0	1(0.3)	0	0	0	0	1(0.1)	3(0.1)
Spottail Shiner	0	0	2(0.3)	0	0	0	0	0	0	0	2(0.1)
9-Spine Stickleback	1(0.3)	0	0	0	0	0	0	0	0	0	1(0.0)
Iowa Darter	0	1(0.4)	0	0	0	0	0	0	0	0	1(0.0)
Unknown	0	0	0	6(6.0)	0	0	0	1(0.6)	0	0	7(0.2)
Total Larvae	326	249	761	101	301	145	229	157	165	689	3,123
Catch per Tow	11.6	9.6	31.7	8.4	12.5	12.1	16.4	11.2	13.8	24.6	15.1
Eggs											
Walleye		14									14
Cyprinidae		7									7
Pumpkinseed								2			2

(C98)

TABLE 4.2-12

CATCH PER TOW OF LARVAL FISH BY DATE - 1986

	April 29-30	May 8	May 11-13	May 21-23	June 3-4	June 9-11	July 12	July 16-17
Larvae								
Yellow Perch	0.1			8.3	14.0	6.0	5.2	1.4
Pumpkinseed							19.7	7.0
White Sucker				0.0	5.5	17.6	0.9	0.1
Cyprinidae						0.5	7.4	5.4
Logperch					0.5	1.1		
Cisco	2.6		0.4					
Lake Whitefish	0.2		0.6	0.1				
Burbot		0.3	0.1					
Golden Shiner								0.2
Walleye				0.1		0.0		
Spottail Shiner							0.1	
9-Spine Stickleback								0.0
Iowa Darter					0.0			
Unknown							0.2	
Eggs								
Walleye		0.6		0.2				
Cyprinidae					0.2			
Pumpkinseed								0.1
Number of Tows	12	16	14	31	31	30	30	30

88-225

(C98)

TABLE 4.2-13

TOTAL CATCH IN PLANKTON DRIFT NETS SET ON FIVE OCCASIONS IN THE OUTLET CHANNELS OF THE COOLING CIRCUIT LAKES - MAY 8-22, 1986

Location	Walleye Eggs	White Sucker Eggs	Logperch Larvae	Decayed Larval Fish	Number of Nets Set
Snow Lake Outlet	0	265	0	0	15
Icy Lake Outlet	0	498	0	0	15
Ski Lake Outlet	0	3,927	2	0	14
Abie Lake Outlet	1	0	0	1	15
Anderson Dam Channel (Marmion Lake Outlet)	0	2	0	0	15

TABLE 4.2-14

CATCH IN LARVAL TOW NETS SET ON FIVE OCCASIONS IN THE SNOW LAKE OUTLET AND AT THE SPILLWAY DAM APRIL 29 - JULY 13

	Snow Lake Outlet	Spillway Dam
Walleye	1	0
Walleye Eggs	80	156
White Sucker	29	0
White Sucker Eggs	251	17,019
Lake Whitefish	0	1
Yellow Perch	26	2
9-Spine Stickleback	0	2
Cyprinid Eggs	25	72
Unidentifiable Larvae	2	0

(C98)

of the amount of water filtered by the plankton nets cannot be made. However, it can be assumed that substantially more water was sampled by the nets set in the shallow channels (Snow, Icy and Ski Lake outlets) than in the relatively deep channels (Abie and Marmion Lake outlets).

Entrainment:

Tow nets were hung in the intake forebay of the station at a location where currents were strongest (>50 cm/sec) to sample icthyoplankton entrainment in the condenser cooling water system. The nets were set for a total of 648 sampling hours between April 30 and July 15 excluding the latter half of June and early July when the CCW pumps were not operating. The results of these samples are listed by date in Appendix 9 and summarized in Table 4.2-15.

Only 56 eggs and 7 larvae were collected during the sampling. Only percid (Iowa darter?) eggs were collected in relatively large numbers. In addition to the eggs and larvae collected, adult yellow perch and slimy sculpin were also collected suggesting that it is not likely that entrained larvae could actively avoid the collection net.

A comparison of the results of 5-min larval tow net sampling in Moose Lake (Appendix 6) with the results of entrainment sampling (Appendix 9) indicates that, despite a substantially lower level of effort, the mean catch of larvae per 5-min tow between April 29 and June 12 in Moose Lake (28 per tow, 674 total) was substantially greater than the 7 larvae collected in the forebay over the same period of time. Consequently, larvae are entrained at substantially lower densities than they exist in the lake suggesting that losses of recruits due to entrainment of eggs and larvae of species susceptible to entrainment in May and early June would not be substantial.

4.2.4 Walleye Spawning

A summary of walleye spawning observations is presented in Table 4.2-16. Spawning activity was assumed to have initiated on or before the weekend of April 19-20 at Ski Lake and likely continued to at least April 29 when adult walleye were observed at the Spillway Dam and at the Snow Lake outlet.

Two observations of walleye spawning are of particular interest: 1) the presence of ripe walleye and white suckers at the Ski Lake outlet and 2) the capture of a walleye larva simultaneously with a relatively large number of undeveloped walleye eggs, white sucker larvae and developed white sucker eggs at the Snow Lake outlet on April 29. Based on observations from previous years, walleye completed spawning prior to initiation of spawning by white suckers, however, in 1986 walleye and white suckers were observed together at Ski Lake. In addition, at Snow Lake white sucker larvae and developed eggs were collected simultaneously with fresh walleye eggs indicating that white suckers in fact spawned prior to some walleye at that location.

The collection of a walleye larva in the same nets as undeveloped walleye eggs suggests that spawning either occurred over a relatively long period of time or over two or more runs. Assuming that the walleye larva was spawned at the Snow Lake outlet and not upstream in Snow Lake where temperatures may have been warmer and that the temperature at the Snow Lake outlet did not exceed 7° during April (the maximum temperature recorded at the Snow Lake outlet April 21-29 was 7.5 ° and temperatures recorded by G&HE at the outflow were lower than 7 degrees through April, Appendix 10) the larva collected at the Snow Lake outlet would have been spawned at least one month earlier (OHRD Report No 81-77-K) which would indicate that some walleye spawning may have taken place in March.

TABLE 4.2-15

TOTAL CATCH IN TOW NETS SET IN THE ATIKOKAN FOREBAY
APRIL 30 TO JULY 15

		Duration of Sets				
		6 hr. n=18	12 hr. n=4	18 hr. n=2	24 hr. n=19	Total n=43
White Sucker	Eggs	0	1	0	1	2
	Larvae	0	0	0	2	2
Logperch	Eggs	54	0	0	0	54
Coregonid	Larvae	0	1	0	0	1
Yellow Perch	Larvae	1	0	0	1	2
	Adults	17	1	13	5	36
9-Spine Stickleback	Larvae	2	0	0	0	2
Slimy Sculpin	Adults	1	0	0	1	2
Total	Eggs	54	1	0	1	56
	Larvae	3	1	0	3	7
	Adults	18	1	13	6	38
Number (%) Zero Catches		10(56%)	3(75%)	1(50%)	13(68%)	27
Total Hours Sampled		108	48	36	456	648

(C98)

88-225

Table 4.2-16

Walleye Spawning April 1986

Date	Location	Observation	Comments
April 19-20	Ski Lake	Spawning Activity	Conservation Officer
April 21	Ski Lake	No Walleye	Temp = 6°C
	Snow Lake	No Walleye	Temp = 5°C
April 22	Ski Lake	25 Walleye	
	Snow Lake	200 Walleye	Temp = 7°C
April 23	Ski Lake	25 Walleye Suckers Present	Temp = 10°C 1 Prespawn F. 10 Males
	Snow Lake	Walleye Present	Temp = 8°C 2 Ripe Males 2 Prespawn F.
April 24	Ski Lake	Walleye Present Suckers Present	Temp = 10°C 1 Postspawn F. 10 Postspawn M.
	Snow Lake	Walleye Present	Temp = 7.5°C 1 Postspawn F. 9 Postspawn M.
April 25	Snow Lake	Walleye Present	Temp = 7°C Postspawn M.
April 26	Ski Lake	Walleye Present	Temp = 10°C 1 Ripe Female 1 Postspawn F. 8 Postspawn M.
April 28-29	Spillway	Walleye Present	Temp = 7°C Adult in Drift Net 156 Eggs in Drift Net
April 29	Snow Lake	Walleye Present	Temp = 7°C 9 Males 1 Larva in Drift Net 80 Eggs in Drift Net
	Ski Lake	No Walleye Suckers Present	Temp = 11.5°C

These two observations could potentially have the same explanation. Assuming that two populations of walleye (those resident in Icy Lake and those migrating from Abie and Marmion Lakes) utilize the two spawning locations in Icy Lake, than the two populations would, presumably, have been exposed to different thermal regimes prior to spawning. The Marmion Lake residents would have been exposed to natural late winter temperatures while those resident in Icy Lake would have been exposed to elevated temperatures due to the influence of the thermal discharge. Consequently, the walleye from Icy Lake would have been ready to spawn earlier than those migrating from the downstream lakes, thus suggesting two spawning runs at the Snow Lake outlet. Similarly, white suckers from Icy Lake would be expected to spawn earlier than normal and thus their timing coincided with that of walleye migrating from Marmion Lake at Ski Lake and preceded the migrating walleye at the Snow Lake outlet. This hypothesis is based on very limited data; analysis of data from 1987 and 1988 should assist in verification of the hypothesis.

The collection of a single walleye egg at the outlet of Abie Lake suggests that some spawning occurred at that location. Walleye spawning at that location was last observed in 1981.

4.2.5 Age and Year-Class Distribution

The age and year-class distributions of northern pike, walleye, lake whitefish and cisco collected in 1986, commissioning and preoperational studies are presented in Figures 4.2-12 to 4.2-15.

As in preoperational studies, 4 and 5-year old northern pike were the most common age classes. The year-class distributions of northern pike over the three sets of data do not indicate any particularly strong year-classes but do suggest that the 1980 year-class may have been relatively poor.

The most frequent age-classes of walleye collected in 1986 were 5 and 6 compared to ages 3 to 6 during the preop and ages 5 to 7 during commissioning. Based on the year-class distributions, the 1978 year-class appeared to be relatively strong during preoperational and commissioning studies but had apparently lost its importance by 1986. However, the accuracy of aging walleye from scales is reduced in walleye older than 7 or 8 years of age and thus some of the 1978 year-class may have been included with the 1977 or 1979 year-classes. Exceptionally weak year-classes were not apparent.

Lake whitefish aged 8 and 9 were the most frequently represented age-classes in 1986. The distribution of age-classes of lake whitefish during the preoperational and commissioning studies were heavily influenced by very strong 1972 and 1973 year-classes. These year-classes, aged 13 and 14 in 1986, however, had virtually disappeared from the 1986 sample.

The age distributions of cisco suggest highly variable year-class strengths. The most commonly collected age-classes in 1986 were 2, 3, and 6 compared to 3, 4, 5 and 9 during the preop and 4, 5 and 8 during commissioning.

5.0 CONCLUSIONS

1. The depth of the thermocline during the summer in the first three lakes in the cooling water circuit (Snow, Icy and Abie) was greater than that observed prior to full station operation.

2. Hypolimnetic oxygen depletion which was prevalent in all of the study lakes during the summer in previous years was much less acute in 1986. Higher oxygen concentrations in

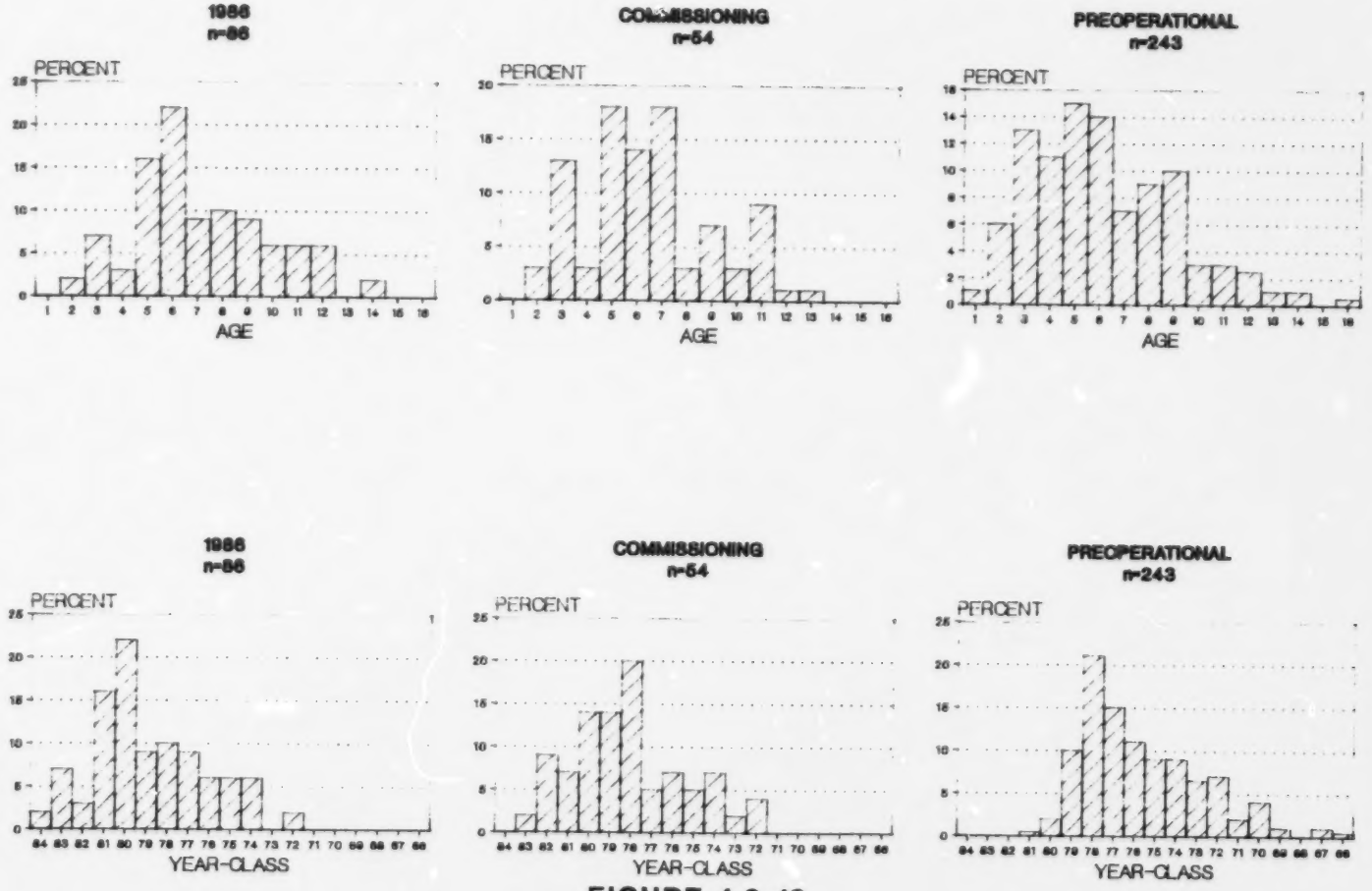

FIGURE 4.2-12

AGE AND YEAR-CLASS DISTRIBUTION OF WALLEYE

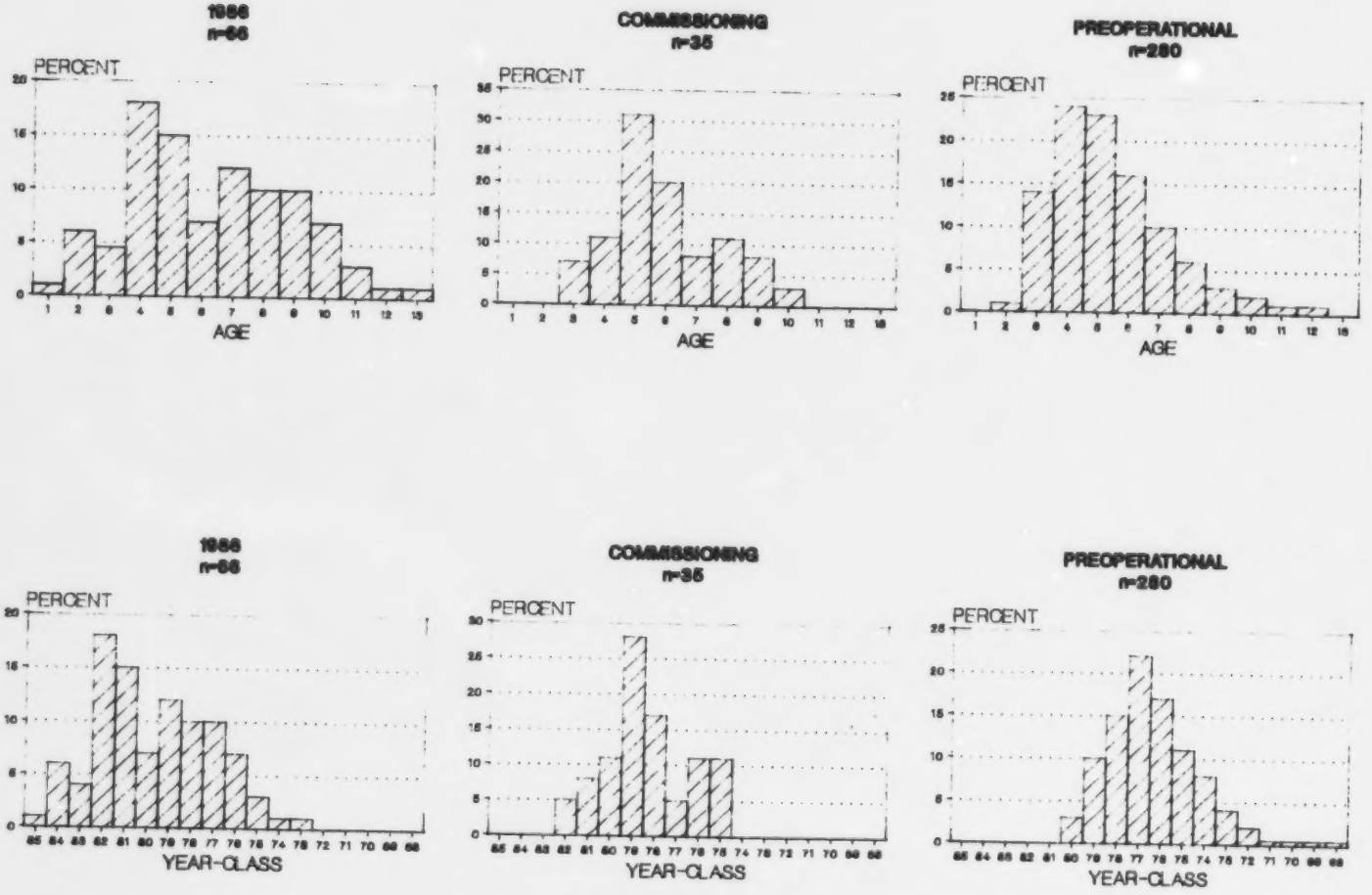

FIGURE 4.2-13

AGE AND YEAR-CLASS DISTRIBUTION OF NORTHERN PIKE

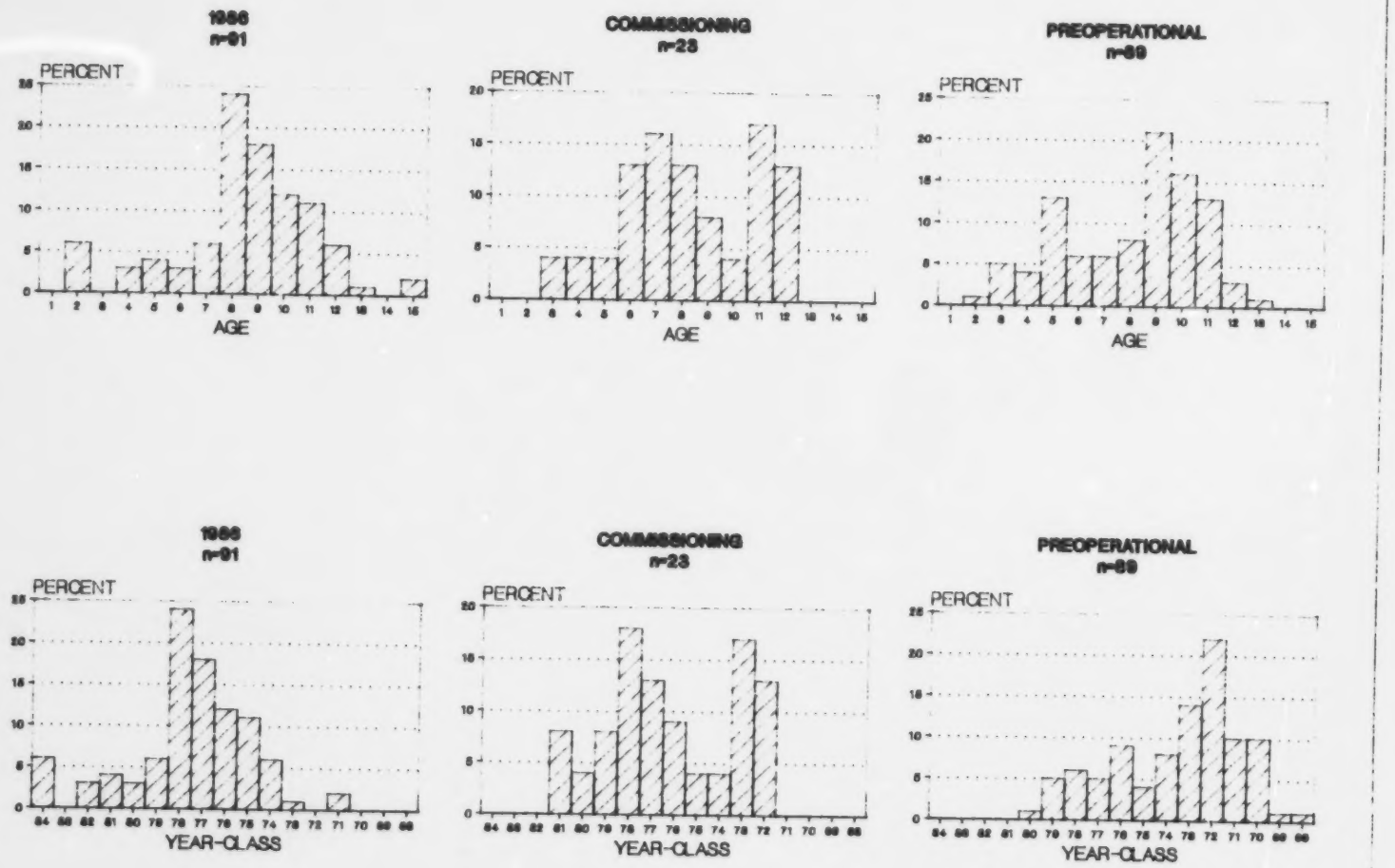

FIGURE 4.2-14

AGE AND YEAR-CLASS DISTRIBUTION OF LAKE WHITEFISH

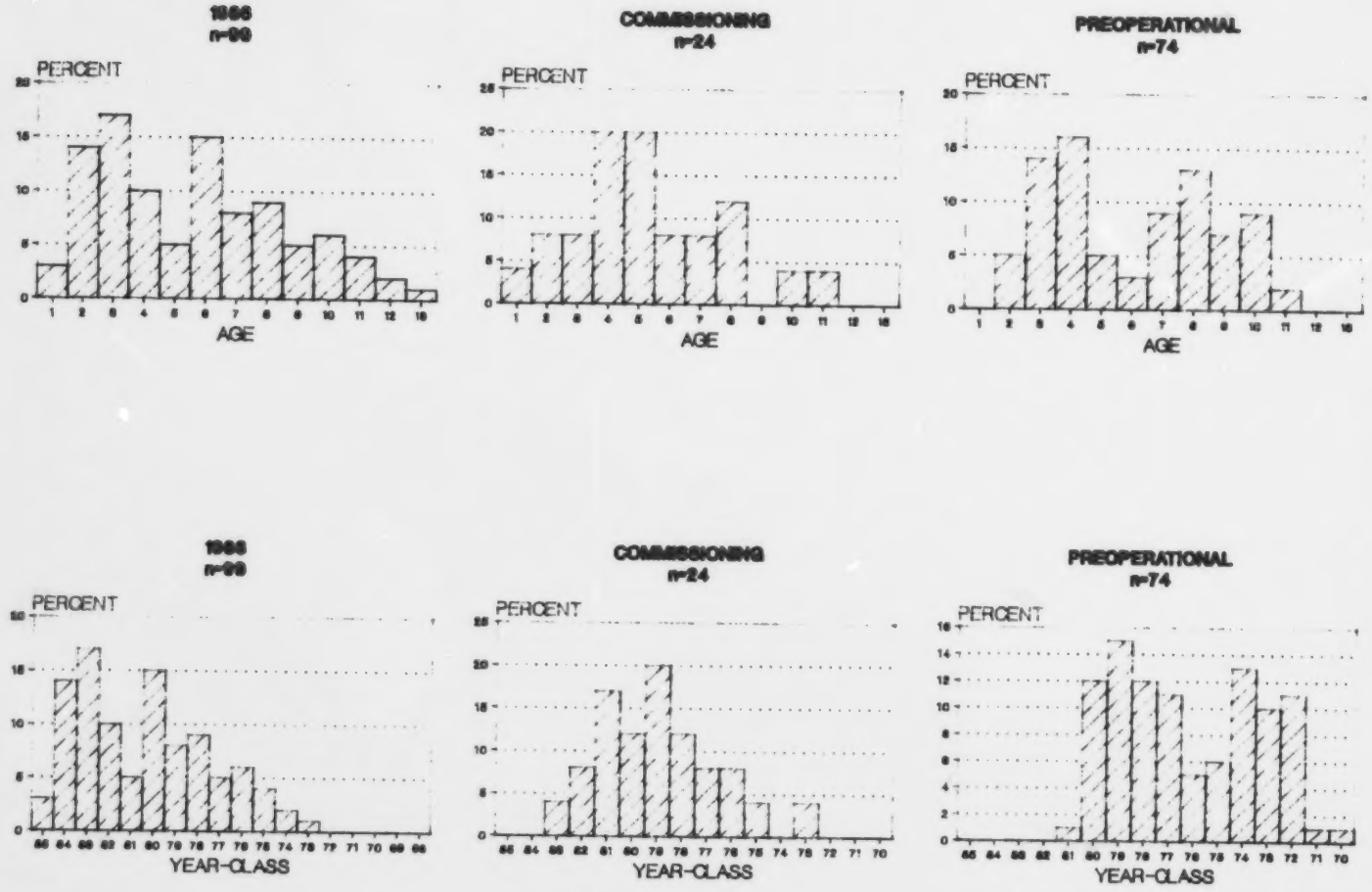

FIGURE 4.2-15

AGE AND YEAR-CLASS DISTRIBUTION OF CISCO

bottom waters were typical of all study lakes and consequently, the improved oxygen conditions cannot be attributed directly to the station.

3. Nutrient concentrations in surface and bottom waters during 1986 were similar to or lower than previously reported values.

4. Extended distributions of macrophytes in areas of Abie and Marmion Lakes may be attributable to stabilized water levels.

5. Changes in sedimentation patterns as a result of currents established by the station discharge may be responsible for a reduction in the density of macrophytes in some areas of Icy Lake.

6. The catch per unit of effort of walleye and northern pike in gillnets was below the range of values previously reported. This apparent reduction may be, in part, attributable to the increased duration of gillnet sets at some locations.

7. The composition of fish collected in beach seines, averaged over all locations was similar to previous years. At Snow and Icy Lakes, however, the contribution of yellow perch to the catch increased substantially.

8. Some walleye appeared to have spawned as much as a month earlier than in previous years at or upstream of the Snow Lake outlet. In addition, white suckers, which generally spawn after walleye, spawned prior to and simultaneously with some walleye at both the Ski and Snow Lake sites.

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APPENDIX 1

TEMPERATURE, DISSOLVED OXYGEN AND pH PROFILES 1986

S N O W L A K E

TEMPERATURE (°C)

DEPTH(m)	04/30	05/21	06/03	06/09	07/12	08/11	09/09	09/15	10/22
0	6.8	12.3	18.8	21.2	18.1	20.6	21.8	18.4	11.2
1	6.8	12.2	18.8	21.2	18.1	20.6	18.5	18.0	11.0
2	6.8	12.1	18.8	21.0	18.1	20.6	18.2	15.6	10.9
3	6.8	11.9	18.6	18.0	18.2	20.6	17.8	15.5	10.9
4	6.8	11.3	18.2	17.6	18.1	20.6	16.9	15.4	10.6
5	6.7	11.1	15.3	17.2	18.0	20.5	16.5	15.3	9.7
6	6.7	10.9	13.5	15.8	18.0	20.4	16.4	15.1	9.5
7	6.7	10.6	11.8	12.0	17.8	18.3	16.2	15.1	9.4
8	6.7	9.5	10.6	9.5	12.4	13.7	16.0	15.0	9.3
9	6.7	8.8	9.4	9.0	11.3	11.8	15.6	14.7	9.2
10	6.6	8.1	8.7	8.8	10.4	10.1	13.2	14.6	9.2

DISSOLVED OXYGEN (PPM)

0	13.9	11.4	9.8	8.9	9.0	8.5	9.4	8.9	8.9
1	14.1	11.3	9.6	8.9	9.0	8.4	10.0	9.2	8.9
2	14.0	11.4	9.6	8.8	9.0	8.4	10.0	9.2	8.9
3	14.0	11.5	9.6	9.3	8.9	8.3	10.0	9.2	8.9
4	14.0	11.5	9.7	9.3	8.8	8.3	10.0	9.2	8.7
5	14.0	11.5	10.6	9.1	8.7	8.0	9.9	9.2	8.8
6	14.1	11.4	11.0	9.4	8.6	7.8	9.7	9.1	8.7
7	14.0	11.5	11.0	8.9	8.2	3.1	9.3	9.2	8.6
8	13.9	11.5	11.1	6.0	4.5	2.6	9.0	9.1	8.6
9	14.0	10.7	10.2	4.5	4.1	2.9	8.0	8.0	8.4
10	13.9	9.4	10.2	4.0	4.0	3.2	4.5	7.7	8.3

pH

S	7.6	7.4	7.7	7.6	7.3	7.8	7.7	7.6	7.9
M	7.5	7.3	7.4	7.2	7.2	7.4	7.5	7.5	7.8
B	7.4	6.6	6.9	6.1	6.5	6.8	6.8	7.2	7.6

APPENDIX 1 (CONT'D)

I C Y L A K E

TEMPERATURE °C

DEPTH(m)	04/26	05/25	06/06	06/10	07/14	08/08	09/10	09/16	10/22
0	7.9	16.3	20.0	19.3	18.9	21.2	17.8	15.3	9.9
1	7.8	15.9	19.9	19.3	18.9	21.2	17.8	15.3	9.9
2	7.8	15.8	19.9	19.2	18.9	21.2	17.5	15.3	9.8
3	7.7	15.3	19.6	18.7	18.5	21.1	17.2	15.3	9.8
4	7.7	13.5	17.3	17.6	18.4	21.0	16.3	15.3	9.8
5	7.7	13.0	15.3	16.5	18.2	20.7	16.1	15.2	9.7
6	7.7	12.2	12.8	13.9	17.9	19.3	16.1	15.0	9.6
7	7.7	11.1	11.7	11.3	17.5	16.8	16.0	14.9	9.3
8	7.6	10.3	11.1	10.4	14.3	15.4	16.0	14.9	8.8
9	7.6	9.5	10.4	9.5	11.5	12.6	15.6	14.9	8.4
10	7.6	9.0	9.5	9.0	10.3	10.5	12.8	14.6	8.4
11	-	8.8	9.1	8.7	-	-	10.2	14.4	-
12	-	-	8.8	-	-	-	-	-	-

DISSOLVED OXYGEN(PPM)

0	12.0	10.2	8.9	7.5	8.1	7.6	7.8	7.7	9.3
1	12.1	10.2	8.9	7.5	8.1	7.6	7.8	7.7	9.2
2	12.2	10.4	8.9	7.5	8.0	7.6	7.8	7.6	9.2
3	12.2	10.4	8.8	7.4	7.9	7.5	7.7	7.7	9.2
4	12.2	10.8	9.4	7.5	7.9	7.4	7.7	7.6	9.2
5	12.4	10.8	9.8	7.5	7.8	7.1	7.5	7.6	9.2
6	12.6	10.8	9.2	6.9	7.4	5.1	7.5	7.3	9.1
7	12.9	10.3	8.6	6.3	6.5	2.9	7.2	7.4	8.9
8	13.2	8.5	7.3	5.2	2.4	1.6	7.1	7.2	8.5
9	13.4	6.6	6.8	2.7	2.4	1.8	6.6	7.1	7.8
10	13.8	5.2	4.9	1.8	2.3	2.0	1.6	6.3	7.7
11	-	4.3	4.4	1.9	-	-	1.6	2.1	-
12	-	-	4.3	-	-	-	-	-	-

pH

S	7.5	7.6	7.8	7.7	7.5	7.9	7.8	7.6	7.6
M	7.5	7.2	6.9	7.4	7.3	7.5	7.5	7.4	7.6
B	7.6	6.6	6.3	6.8	6.4	6.8	7.1	7.2	7.1

APPENDIX 1 (CONT'D)

A B I E L A K E

TEMPERATURE °C

DEPTH(m)	04/26	05/25	06/10	07/14	08/08	09/10	09/16	10/18	10/23
0	8.0	17.0	19.0	19.2	21.7	16.7	15.5	8.4	9.2
1	7.7	16.9	19.0	19.2	21.4	16.6	15.3	8.4	9.2
2	7.7	16.9	19.0	19.2	21.1	16.5	15.0	8.3	9.1
3	7.7	15.6	18.9	19.2	21.1	16.3	14.9	8.2	9.0
4	7.7	15.0	18.7	19.1	21.0	16.3	14.8	8.2	9.0
5	7.7	14.7	17.9	18.8	20.7	16.2	14.5	8.3	9.0
6	7.7	12.3	17.1	18.6	20.1	15.6	14.3	8.2	9.0
7	7.6	12.2	14.8	18.4	19.4	15.5	14.3	8.2	9.0
8	7.6	9.7	12.1	15.4	16.7	15.5	14.3	8.2	9.0
9	7.5	9.5	11.1	13.7	-	15.4	14.3	8.2	9.0

DISSOLVED OXYGEN (PPM)

0	11.2	9.4	7.6	8.3	8.2	8.0	7.9	9.1	8.9
1	11.2	9.3	7.6	8.4	8.2	8.0	7.9	9.3	8.9
2	11.3	9.3	7.6	8.3	8.2	8.1	7.9	9.1	8.8
3	11.3	9.5	7.5	8.3	8.1	7.9	7.8	9.2	8.8
4	11.3	9.6	7.4	8.2	8.1	7.8	7.8	9.1	8.9
5	11.5	9.4	7.3	8.0	7.7	7.6	7.8	9.1	8.8
6	11.6	9.5	7.2	7.8	7.1	7.5	7.8	9.1	8.8
7	11.7	9.3	6.6	7.5	5.7	7.4	7.8	9.0	8.8
8	11.8	5.6	4.6	5.8	2.5	7.4	7.8	9.0	8.8
9	12.5	5.6	2.6	2.9	-	7.4	7.8	9.0	8.7

pH

S	7.5	7.7	7.8	7.6	7.9	7.8	7.8	8.2	8.0
M	7.5	7.5	7.6	7.4	7.6	7.7	7.7	8.2	8.0
B	7.5	6.7	6.9	6.6	6.6	7.5	7.6	8.3	7.9

APPENDIX 1 (CONT'D)

S L U S H L A K E

TEMPERATURE (°C)

DEPTH(m)	04/27	05/21	06/03	06/09	07/12	08/10	09/09	09/15	10/17	10/22
0	6.4	16.2	18.1	19.7	19.1	20.3	16.5	14.3	8.2	8.4
1	6.4	16.2	18.0	19.7	19.1	20.3	15.6	14.1	8.1	8.4
2	6.4	16.0	18.0	19.6	9.0	20.3	15.4	14.0	8.1	8.2
3	6.4	15.8	17.8	18.4	9.0	20.2	15.1	14.0	8.1	8.0
4	6.4	11.0	13.8	17.5	9.0	19.9	14.9	13.9	8.1	7.9
5	6.4	8.8	11.8	11.5	18.7	18.8	14.8	13.7	8.1	7.8
6	6.4	7.7	9.3	9.4	13.3	16.1	14.7	13.7	8.0	7.8
7	6.2	7.5	8.0	8.4	8.9	11.2	14.6	13.6	7.9	7.8
8	6.1	6.9	6.9	7.2	6.9	9.0	11.7	13.4	7.9	7.8
9	5.6	6.2	6.6	6.6	6.3	7.5	8.1	8.6	7.9	7.7
10	5.4	6.0	6.3	6.3	6.3	6.9	6.9	7.1	7.9	7.7
11	5.3	6.0	6.3	6.2	6.3	6.4	6.8	6.8	7.9	7.7
12	5.3	6.1	-	-	-	6.3	6.8	6.7	-	-

DISSOLVED OXYGEN (PPM)

0	11.8	9.7	10.0	9.5	9.1	9.1	10.9	10.2	-	9.5
1	11.8	9.8	10.1	9.5	9.1	9.0	11.1	10.2	-	9.5
2	11.8	9.8	10.1	9.4	9.1	8.9	11.1	10.2	-	9.4
3	11.8	9.8	10.1	9.5	8.9	8.8	11.1	10.3	-	9.3
4	11.8	9.9	12.6	9.9	8.9	8.7	11.0	10.1	-	9.2
5	11.8	9.8	13.4	12.3	8.6	9.4	10.8	10.1	-	9.2
6	11.8	11.8	13.7	12.4	11.3	10.6	10.4	9.7	-	9.2
7	11.8	11.3	12.9	12.2	10.9	11.4	10.9	9.4	-	9.1
8	11.8	10.8	11.0	10.6	9.0	10.5	8.1	9.1	-	9.1
9	11.5	9.7	10.0	8.9	6.8	8.6	6.3	7.3	-	8.9
10	11.5	8.5	8.3	8.3	6.7	6.7	6.0	5.3	-	8.8
11	11.5	8.5	8.0	8.3	6.6	4.5	6.0	4.5	-	8.7
12	11.7	8.8	-	-	-	4.5	-	4.5	-	-

pH

S	6.9	7.7	7.6	7.7	7.5	7.6	7.5	7.5	7.4	6.9
M	6.7	6.7	7.0	7.1	7.4	7.5	7.2	7.2	7.4	6.8
B	6.1	6.4	5.7	5.2	6.0	6.1	6.1	6.5	7.5	6.7

APPENDIX 1 (CONT'D)

M A R M I O N S O U T H

TEMPERATURE (°C)

DEPTH(m)	04/26	05/25	06/06	06/10	07/14	08/08	09/10	09/16	10/18	10/23
0	6.2	16.4	18.0	17.7	18.8	21.0	15.8	14.6	8.5	8.7
1	6.1	16.0	17.8	17.7	18.7	21.0	15.8	14.6	8.4	8.7
2	6.1	15.5	17.5	17.7	18.6	20.9	15.8	14.5	8.4	8.7
3	6.0	14.4	17.0	17.6	18.4	20.8	15.7	14.5	8.4	8.7
4	6.0	13.2	16.6	16.5	18.3	20.8	15.7	14.3	8.4	8.7
5	6.0	12.7	15.5	15.8	18.2	20.6	15.6	14.3	8.4	8.7
6	5.9	11.1	12.9	13.9	18.2	20.5	15.6	14.3	8.3	8.7
7	5.8	9.8	11.0	13.6	18.0	20.4	15.5	14.2	8.3	8.7
8	5.7	8.9	10.1	10.8	15.8	19.3	15.4	14.2	8.3	8.7
9	5.7	8.7	9.7	9.4	14.1	16.3	15.3	14.2	8.3	8.6
10	5.7	8.4	8.9	9.0	12.9	14.3	15.2	14.2	8.3	8.6
11	5.6	8.2	8.5	8.8	11.6	12.1	14.7	14.1	8.3	8.6
12	5.6	7.9	8.2	8.4	9.9	10.0	13.2	13.8	8.3	8.6
13	5.6	7.8	7.8	7.8	8.6	9.1	10.4	11.2	8.3	8.5
14	5.6	7.7	7.3	7.5	7.7	8.1	8.7	8.8	8.3	8.4
15	5.6	7.3	7.2	7.1	7.2	7.5	7.9	7.7	8.3	8.3
16	5.6	7.1	6.9	6.8	6.9	7.2	7.2	7.1	8.2	8.3
17	-	-	-	-	6.7	6.8	6.9	6.9	-	-

DISSOLVED OXYGEN (PPM)

0	11.1	9.2	9.0	7.9	9.4	8.8	7.9	7.9	8.7	8.8
1	11.1	9.2	8.9	7.8	9.5	8.8	7.8	7.8	8.7	8.7
2	11.2	9.3	9.0	7.8	9.5	8.8	7.8	7.8	8.6	8.6
3	11.2	9.4	9.0	7.8	9.5	8.7	7.7	7.8	8.6	8.7
4	11.2	9.7	9.0	7.9	9.4	8.7	7.8	7.8	8.6	8.6
5	11.2	9.7	9.1	7.9	9.3	8.6	7.8	7.8	8.7	8.6
6	11.2	9.9	9.8	8.0	9.2	8.5	7.7	7.8	8.7	8.6
7	11.2	10.0	9.5	7.9	9.0	8.1	7.7	7.7	8.7	8.6
8	11.3	9.7	9.4	7.7	7.8	7.1	7.5	7.5	8.7	8.6
9	11.4	9.7	9.2	7.5	7.1	5.3	7.2	7.5	8.7	8.6
10	11.4	9.6	9.1	7.4	7.0	4.3	7.1	7.5	8.7	8.6
11	11.4	9.5	9.1	7.5	7.1	5.4	6.4	7.4	8.7	8.5
12	11.7	9.6	9.1	7.4	7.7	5.4	3.1	6.8	8.8	8.4
13	11.8	9.5	9.1	7.1	7.5	5.6	1.6	2.5	8.7	8.3
14	11.9	9.2	8.6	6.6	6.4	4.6	1.5	1.9	8.7	8.2
15	11.9	8.9	8.3	6.0	5.6	3.8	1.6	1.8	8.7	8.2
16	12.1	8.9	7.9	5.8	4.7	3.4	1.7	1.9	8.7	8.2
17	-	-	-	-	4.6	3.4	1.7	2.0	-	-

pH

S	7.3	7.7	7.8	7.8	7.7	8.0	7.7	7.5	8.0	8.0
M	7.3	7.1	6.9	7.1	7.0	6.8	7.4	7.3	7.9	8.0
B	7.6	6.9	6.5	6.8	6.5	6.2	6.7	7.0	7.9	7.7

APPENDIX 1 (CONT'D)

M A R M I O N N O R T H

TEMPERATURE (°C)

DEPTH(m)	04/28	05/23	06/04	06/11	07/12	08/09	09/11	09/16	10/16	10/20
0	6.1	15.2	17.2	17.3	19.2	21.3	16.1	14.4	8.6	9.1
1	6.0	15.2	17.2	17.3	19.2	21.3	16.1	14.4	8.6	9.1
2	5.8	15.1	17.2	17.3	19.2	21.3	15.8	14.3	8.6	9.0
3	5.7	15.1	17.1	17.3	19.2	21.3	15.8	14.2	8.6	8.9
4	5.6	15.1	16.9	17.2	19.2	21.3	15.7	14.2	8.6	8.6
5	5.6	15.0	15.9	17.1	19.2	21.1	15.7	14.2	8.5	8.5
6	5.6	11.7	14.0	16.9	19.2	20.1	15.4	14.2	8.5	8.4
7	5.6	10.0	11.3	14.1	19.2	19.1	15.3	14.1	8.5	8.4
8	5.6	9.0	9.9	11.6	19.1	18.4	15.2	14.1	8.5	8.3
9	5.6	8.5	8.9	10.1	16.2	14.7	15.1	14.1	8.5	8.3
10	5.6	8.2	8.5	9.2	12.7	11.2	15.0	14.1	8.5	8.3
11	5.6	8.1	8.2	8.5	10.2	9.7	14.5	13.8	8.5	8.3
12	5.6	7.9	7.8	7.5	8.6	9.4	11.2	12.3	8.4	8.2
13	5.6	7.4	6.6	7.0	7.6	8.2	8.8	9.0	8.4	8.0
14	5.6	6.9	6.4	6.4	6.9	7.2	7.8	8.0	8.1	8.0
15	5.6	6.3	6.1	6.1	6.8	7.1	7.2	7.1	8.0	7.9
16	5.6	6.4	6.1	6.1	-	6.7	-	6.9	-	7.8

OXYGEN (PPM)

0	10.9	10.9	9.7	9.0	10.0	8.0	8.1	8.4	9.4	10.3
1	10.9	10.9	9.7	8.9	9.9	8.1	8.1	8.4	9.3	10.2
2	10.8	10.9	9.6	8.9	9.8	8.0	8.1	8.4	9.2	10.2
3	10.8	10.9	9.5	8.9	9.8	8.0	8.0	8.4	9.3	10.1
4	10.8	10.9	9.4	8.9	9.8	7.9	8.0	8.3	9.3	10.1
5	11.0	10.9	9.4	8.8	9.7	7.6	7.8	8.3	9.3	10.0
6	10.8	12.0	9.7	8.6	9.7	7.0	7.6	8.2	9.3	10.0
7	10.7	12.3	10.4	8.0	9.4	5.2	7.6	8.1	9.3	10.0
8	10.6	12.3	10.6	9.0	9.2	5.2	7.5	8.1	9.3	10.0
9	10.6	11.6	10.6	9.0	8.2	4.5	7.4	8.0	9.3	10.1
10	10.7	11.2	10.6	9.2	8.3	4.6	7.1	7.8	9.2	10.0
11	10.6	10.9	10.4	9.0	8.3	4.6	6.0	6.9	9.2	10.0
12	10.6	10.7	10.4	8.8	7.9	4.4	2.7	2.9	9.2	10.0
13	10.6	10.6	9.5	7.8	6.2	3.2	2.0	2.4	9.1	10.1
14	10.6	10.2	8.7	6.2	5.6	2.6	2.1	2.6	9.4	10.0
15	10.5	9.4	7.6	5.2	5.5	2.6	2.1	2.4	9.5	9.8
16	10.5	7.9	7.3	5.0	-	2.6	-	2.6	-	9.5

pH

S	7.3	7.7	7.8	7.8	7.7	8.0	7.7	7.5	8.0	8.0
M	7.3	7.1	6.9	7.1	7.0	6.8	7.4	7.3	7.9	8.0
B	7.6	6.9	6.5	6.8	6.5	6.7	6.7	7.0	7.9	7.7

APPENDIX 1 (CONT'D)

MARMION CENTRAL

TEMPERATURE (°C)

DEPTH(m)	04/26	05/25	06/06	06/10	07/12	08/06	09/10	09/16	10/16	10/20
0	5.5	16.1	17.5	18.2	18.6	21.2	15.6	14.5	8.7	8.9
1	5.1	15.4	17.3	18.1	18.6	21.2	15.6	14.4	8.7	8.9
2	5.0	14.8	17.3	17.8	18.6	21.1	15.4	14.4	8.7	8.9
3	5.0	13.9	16.9	17.6	18.6	21.0	15.3	14.2	8.7	8.9
4	5.0	13.3	16.4	16.8	18.7	20.8	15.2	14.1	8.6	8.8
5	5.0	12.8	16.2	16.2	18.6	20.7	15.2	14.1	8.6	8.9
6	5.0	12.0	13.8	15.7	18.6	20.6	15.1	14.1	8.6	8.8
7	5.0	9.9	12.2	13.9	18.5	19.4	15.1	14.1	8.6	8.8
8	5.0	9.3	10.5	11.5	18.5	18.8	15.1	14.1	8.6	8.7
9	5.0	8.7	10.0	10.6	16.1	16.8	15.1	14.1	8.6	8.4
10	4.9	8.6	9.8	10.4	14.2	15.2	15.1	14.1	8.6	8.4
11	4.9	8.6	9.5	10.2	13.2	14.4	15.1	14.1	8.6	-
12	4.9	8.4	9.4	10.0	12.1	12.9	15.0	14.1	-	-
13	4.9	8.4	-	-	-	-	-	-	-	-

DISSOLVED OXYGEN (PPM)

0	10.8	9.2	9.4	9.3	9.4	9.1	9.5	8.3	9.4	8.7
1	10.9	9.2	9.4	9.3	9.3	9.1	9.5	8.2	9.4	8.7
2	11.0	9.2	9.3	9.3	9.3	9.1	9.5	8.2	9.4	8.7
3	11.0	9.5	9.3	9.3	9.2	9.1	9.4	8.2	9.4	8.7
4	11.0	9.6	9.4	9.3	9.2	9.1	9.4	8.2	9.4	8.6
5	11.0	9.6	9.3	9.3	9.1	9.0	9.5	8.2	9.4	8.6
6	11.1	9.6	9.8	9.3	9.1	8.8	9.5	8.2	9.3	8.6
7	11.3	9.7	10.2	9.4	9.0	7.9	9.5	8.2	9.3	8.6
8	11.3	9.4	10.5	9.4	8.7	6.9	9.4	8.2	9.3	8.4
9	11.3	9.4	10.3	9.3	7.4	6.5	9.4	8.1	9.3	8.4
10	11.4	9.4	10.0	9.5	7.3	5.6	9.4	8.1	9.3	8.5
11	11.5	9.4	9.9	9.5	7.0	5.5	9.4	8.1	9.3	-
12	11.5	9.4	9.8	9.3	6.9	4.9	9.4	8.1	-	-
13	11.7	9.4	-	-	-	-	-	-	-	

pH

S	7.1	7.8	7.8	7.7	7.6	8.0	7.6	7.5	7.6	7.6
M	7.2	7.2	7.1	7.3	7.5	7.3	7.5	7.5	7.6	7.5
B	7.5	7.0	6.7	6.7	6.6	6.5	7.4	7.5	7.5	7.5

APPENDIX 1 (CONT'D)

ANDERSON DAM

TEMPERATURE (#C)

DEPTH(m)	04/28	05/25	06/05	06/12	07/15	08/09	09/13	09/18	10/19	10/23
0	7.0	17.0	18.3	16.7	21.1	20.9	14.9	13.4	7.2	7.9
1	6.8	16.1	18.2	16.7	19.5	20.9	14.9	13.4	7.2	7.9
2	6.7	14.9	17.1	16.6	19.2	21.0	14.9	13.4	7.1	7.9
3	6.6	14.3	16.1	16.6	18.9	20.9	14.9	13.4	7.2	7.9
4	6.6	13.4	16.4	16.6	18.6	20.9	14.9	13.4	7.1	7.9
5	6.4	12.7	16.2	16.4	18.4	20.9	14.9	13.4	7.1	7.9
6	6.4	10.6	14.5	14.6	18.3	19.9	14.9	13.4	7.1	7.9
7	6.4	10.0	11.9	13.2	18.2	19.2	15.0	13.4	7.1	7.8
8	6.3	9.5	10.9	11.2	16.4	17.3	15.0	13.4	7.1	7.8
9	6.2	9.3	10.0	10.5	13.3	14.1	15.0	13.4	-	7.8
10	6.1	-	9.8	-	11.4	12.0	15.0	13.3	-	7.8

DISSOLVED OXYZEN (PPM)

0	12.1	9.3	9.0	7.9	8.4	7.6	8.5	8.9	8.9	8.8
1	12.0	9.5	9.0	7.9	8.4	7.5	8.5	8.9	8.8	8.8
2	11.8	9.8	9.2	7.8	8.5	7.6	8.5	8.9	8.8	8.8
3	11.6	9.9	9.2	7.8	8.5	7.5	8.5	8.9	8.9	8.8
4	11.4	10.1	9.1	7.8	8.4	7.4	8.5	8.9	8.9	8.7
5	11.1	10.2	9.0	7.6	8.3	7.3	8.5	8.9	8.9	8.8
6	11.0	10.3	8.8	7.1	8.1	6.3	8.4	8.9	8.8	8.7
7	10.9	10.4	8.9	6.8	7.9	5.2	8.5	9.0	8.9	8.7
8	10.8	10.3	8.6	6.2	6.3	2.9	8.5	9.0	8.0	8.0
9	10.5	10.3	8.2	5.8	3.1	1.6	8.5	8.8	-	8.7
10	10.4	10.3	7.6	-	2.8	1.6	8.5	8.9	-	8.7

pH

S	6.6	7.7	7.7	7.7	7.8	8.1	7.9	7.8	8.4	8.4
M	6.9	7.4	7.4	7.5	7.6	7.9	7.9	7.7	8.3	8.3
B	7.0	6.9	7.0	7.0	6.7	6.9	7.9	7.6	8.2	8.2

APPENDIX 1 (CONT'D)

LOWER SEINE

TEMPERATURE (°C)

DEPTH(m)	04/26	05/24	06/06	06/10	07/13	08/06	09/11	09/16	10/16	10/20
0	5.2	15.1	18.0	18.5	18.7	21.6	15.4	14.4	8.6	8.9
1	5.1	15.1	18.0	18.4	18.7	21.4	15.4	14.4	8.6	8.9
2	5.0	15.1	18.0	18.3	18.7	21.3	15.4	14.4	8.5	8.9
3	5.0	15.1	18.0	18.3	18.6	21.2	15.4	14.3	8.6	8.8
4	5.0	15.0	17.8	18.1	18.6	21.0	15.4	14.1	8.5	8.7
5	5.0	12.7	17.6	17.8	18.6	20.9	15.4	14.0	8.5	8.5
6	5.0	11.0	14.8	15.5	18.6	20.7	15.4	13.9	8.5	8.4
7	5.0	9.9	10.9	12.8	17.2	19.1	15.3	13.9	8.4	8.4
8	5.0	8.9	9.6	9.4	14.6	15.9	15.2	13.9	8.4	8.4
9	5.0	8.7	9.2	9.1	12.4	13.3	15.1	13.8	8.5	8.4
10	5.0	8.4	8.3	8.6	10.3	10.3	14.7	13.7	8.4	8.3
11	5.0	8.1	8.1	8.5	9.2	9.1	10.3	12.5	8.4	8.3
12	5.0	7.9	7.8	-	7.8	8.4	8.8	8.8	8.5	8.3
13	4.9	7.8	7.5	-	7.6	8.1	8.2	8.3	8.4	8.2
14	4.9	7.6	7.4	-	7.6	7.7	7.7	8.0	8.4	8.2
15	4.9	7.5	7.3	-	7.4	7.4	7.6	7.5	8.4	8.1
16	4.9	7.4	-	-	7.3	7.2	7.4	7.5	-	8.1
17	4.9	7.2	-	-	-	7.1	7.2	7.3	-	8.1
18	4.9	-	-	-	-	7.1	7.1	7.3	-	-
19	-	-	-	-	-	-	7.0	-	-	-

DISSOLVED OXYGEN

0	10.8	10.5	9.0	8.0	9.4	9.8	8.2	8.0	8.1	8.1
1	10.8	10.5	9.0	8.0	9.5	9.8	8.2	7.9	8.0	8.1
2	10.9	10.5	8.9	8.0	9.5	9.7	8.2	8.0	7.8	8.1
3	10.9	10.5	8.9	8.0	9.6	9.7	8.2	7.9	7.9	8.1
4	10.9	10.5	8.8	7.8	9.6	9.6	8.1	7.8	7.9	8.0
5	10.9	11.2	8.7	7.8	9.5	9.5	8.1	7.8	8.0	8.0
6	10.9	11.7	9.1	8.0	9.3	8.9	8.0	7.8	8.0	8.0
7	11.0	11.8	9.9	8.2	8.4	7.9	7.9	7.7	8.1	7.9
8	11.0	11.4	9.8	8.3	8.5	6.6	7.7	7.7	8.0	7.9
9	11.1	11.3	9.5	8.3	8.4	6.8	7.5	7.6	8.0	7.9
10	11.1	11.0	9.5	8.1	8.5	7.4	7.0	7.5	8.0	7.8
11	11.2	10.8	9.5	8.0	8.8	8.0	3.8	5.5	8.0	7.9
12	11.2	10.7	9.6	-	8.6	7.8	3.9	3.0	8.0	7.8
13	11.3	10.5	9.5	-	8.5	7.4	3.3	2.8	8.0	7.8
14	11.4	10.5	9.3	-	8.4	7.1	3.1	2.2	8.1	7.8
15	11.4	10.4	9.3	-	8.0	6.1	2.2	1.8	8.1	7.9
16	11.5	10.2	-	-	7.5	5.5	2.1	1.8	-	8.0
17	11.6	10.0	-	-	-	5.2	2.0	1.8	-	8.0
18	11.6	-	-	-	-	5.1	2.1	1.8	-	-
19	-	-	-	-	-	-	1.9	-	-	-

pH

S	6.8	7.8	7.8	7.8	7.7	8.1	7.7	7.5	7.3	7.2
M	6.6	7.0	7.0	7.7	6.9	6.7	7.3	7.2	7.3	7.2
B	6.3	6.7	6.4	7.0	6.4	6.3	6.8	6.5	7.3	7.2

APPENDIX 1 (CONT'D)

MOOSE LAKE

TEMPERATURE (°C)

DEPTH(m)	04/28	05/25	06/05	06/12	07/15	08/09	09/13	09/18	10/19	10/23
0	6.4	17.2	19.5	17.7	22.0	21.4	15.6	14.0	8.0	8.1
1	6.3	17.1	19.3	17.7	21.6	21.4	15.6	14.0	8.0	8.2
2	6.2	16.7	18.8	17.7	20.6	21.4	15.6	14.0	8.0	8.1
3	6.2	16.0	18.3	17.7	20.0	21.4	15.6	14.0	7.9	8.1
4	6.2	15.5	17.9	17.7	19.8	21.4	15.5	14.0	7.9	8.0
5	6.1	15.2	17.8	17.5	19.4	21.3	15.5	14.0	7.9	8.0
6	6.0	15.1	17.7	17.5	19.3	21.3	15.5	14.0	7.9	8.0
7	6.0	14.9	17.3	17.5	19.0	21.2	15.4	14.0	7.8	7.9
8	5.9	14.7	17.1	17.3	19.0	21.1	15.4	14.0	7.8	7.9
9	5.8	14.5	16.9	17.2	18.9	21.1	15.4	13.9	7.8	7.9
10	5.7	14.1	16.8	17.1	18.8	21.0	15.4	13.9	7.8	7.9
11	5.6	13.7	16.6	16.8	18.8	20.9	15.3	13.8	7.8	7.8
12	5.6	12.6	16.4	16.7	18.6	20.8	15.3	13.8	7.7	7.8
13	5.5	11.3	15.9	16.4	18.5	20.6	15.2	13.7	7.7	7.8
14	5.4	9.3	14.7	16.0	18.1	19.9	15.2	13.6	7.7	7.7
15	5.4	6.3	11.6	12.5	14.5	17.2	15.2	13.5	7.7	7.7
16	5.3	6.2	7.3	7.2	8.9	10.2	14.8	13.4	7.7	7.7
17	5.2	6.1	-	6.3	7.5	8.1	12.8	13.2	7.7	7.6
18	5.1	6.0	-	6.2	6.9	7.0	8.8	10.3	7.7	7.5
19	5.0	5.9	-	5.9	6.4	6.6	7.1	6.8	7.6	7.6
20	5.0	5.7	-	5.8	5.8	5.9	6.3	6.2	7.6	7.5
21	4.9	5.5	-	-	5.6	5.7	5.8	5.7	7.5	7.4
22	4.8	5.3	-	-	5.2	5.4	5.5	-	7.5	7.4
23	4.7	5.3	-	-	5.2	5.3	-	-	-	7.4
24	4.7	5.3	-	-	-	5.3	-	-	-	-

DISSOLVED OXYGEN (PPM)

0	12.3	9.1	9.2	7.9	8.5	7.5	8.7	9.2	8.4	8.6
1	12.0	9.1	9.2	7.9	8.5	7.5	8.6	9.2	8.4	8.6
2	11.9	9.2	9.2	7.9	8.7	7.5	8.7	9.1	8.4	8.5
3	11.9	9.2	9.3	7.9	8.8	7.5	8.6	9.1	8.3	8.5
4	11.6	9.2	9.4	7.8	8.8	7.4	8.6	9.1	8.4	8.4
5	11.6	9.3	9.5	7.8	8.6	7.5	8.5	9.1	8.5	8.4
6	11.6	9.2	9.4	7.7	8.5	7.3	8.5	9.1	8.3	8.4
7	11.6	9.2	9.4	7.6	8.4	7.2	8.4	9.1	8.3	8.4
8	11.5	9.2	9.3	7.5	8.5	7.2	8.4	9.0	8.2	8.4
10	11.4	9.2	9.5	7.5	8.6	7.1	8.4	9.0	8.3	8.4
11	11.4	9.2	9.4	7.5	8.6	6.9	8.3	8.8	8.3	8.4
12	11.2	8.9	9.3	7.4	8.4	6.7	8.3	8.7	8.3	8.3
13	11.1	8.5	9.2	7.1	8.1	6.2	8.3	8.7	8.3	8.2
14	11.0	8.7	9.1	6.6	7.6	5.7	8.3	8.6	8.5	8.1
15	10.9	8.7	9.1	6.3	5.3	3.3	8.2	8.6	8.5	8.1
16	10.8	9.0	10.5	7.3	6.9	4.1	7.6	8.5	8.5	8.1
17	10.7	9.0	-	7.5	7.4	4.7	5.2	8.2	8.4	8.0
18	10.7	8.9	-	7.9	7.7	5.0	4.2	4.8	8.5	8.0
19	10.6	8.9	-	7.9	8.0	5.6	4.8	5.8	8.5	7.9
20	10.6	8.8	-	7.9	8.4	6.1	6.5	6.6	8.4	7.9
21	10.6	8.7	-	-	8.5	6.6	6.4	7.1	8.5	7.8
22	10.5	8.6	-	-	8.6	6.5	6.4	-	8.5	7.7
23	10.4	8.4	-	-	8.5	6.7	-	-	-	7.7
24	10.4	8.3	-	-	-	6.7	-	-	-	-

pH

S	7.2	7.8	7.7	7.8	7.8	8.1	7.8	7.6	7.9	8.3
M	6.4	7.3	7.5	7.4	7.3	7.4	7.5	7.4	7.9	8.2
B	5.4	7.2	6.5	6.6	6.6	6.7	6.5	6.9	7.8	8.0

S - Surface
M - Middepth
B - Bottom

APPENDIX 2
MACROPHYTE SPECIES OBSERVED ALONG TRANSECTS
SELECTED FOR SPECIAL STUDY, 1986

APPENDIX 2
MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN SNOW LAKE IN 1986

TRANSECT	1	2	3	4
Callitriche hermaphroditica		X		
Elodea canadensis	X	X	X	X
Megalodonta beckii		X		
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Potamogeton amplifolius	X			
Potamogeton epihydrus	X		X	X
Potamogeton foliusus	X	X		
Potamogeton gramineus	X			
Potamogeton pusillus		X	X	X
Potamogeton richardsonii	X	X	X	X
Potamogeton robbinsii	X		X	X
Potamogeton spirillus	X		X	X
Potamogeton strictifolius	X			
Sagittaria spp	X			

APPENDIX 2
MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN WEST BAY OF ICY LAKE IN 1986

TRANSECTS	1	2	3	4	5	6	7	16	17
Callitriche hermaphroditica	X				X	X			
Elodea canadensis	X				X	X			X
Iris						X			
Megalodonta beckii	X	X	X	X	X	X	X	X	X
Myriophyllum exalbescens	X	X	X	X	X	X	X	X	X
Najas flexilis	X				X	X			
Nymphese odorata	X					X			
Polygonum natans						X			
Potamogeton epihydrus	X				X				
Potamogeton natans	X								
Potamogeton richardsonii	X				X	X	X	X	X
Potamogeton robinsii	X	X	X	X	X	X	X	X	X
Ranunculus tricophyllus					X				
Sagittaria spp	X					X			
Scirpus spp	X					X			
Sparganium fluctuans	X					X			
Typha spp	X					X			
Vallisneria americana							X	X	

APPENDIX 2
MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN EAST BAY OF ICY LAKE IN 1986

TRANSECT	8	9	10	11	12	13	14	15
Brasenia schreberi							X	
Elodea canadensis							X	X
Equisetum sp							X	
Megalodonta beckii							X	X
Myriophyllum exalbescens		X		X	X		X	X
Najas flexilis							X	X
Nymphaea odorata		X	X				X	
Potamogeton friesii							X	X
Potamogeton richardsonii							X	X
Potamogeton robbinsii		X		X	X			X
Potamogeton zosteriformis							X	X
Sagittaria spp							X	
Scirpus spp	X		X	X	X		X	
Sparganium fluctuans							X	
Typha spp	X		X	X	X		X	
Vallisneria americana							X	X

APPENDIX 2
MACROPHYTE SPECIES PRESENT ON TRANSECTS IN ABIE LAKE IN 1986

TRANSECTS	1	2	3	4
Brasenia schreberi			X	
Chara sp	X	X		
Elodea canadensis	X		X	
Megalodonta beckii	X	X	X	
Myriophyllum alterniflorum				X
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Nymphaea odorata	X		X	X
Polygonium natans	X		X	
Potamogeton friesii			X	
Potamogeton gramineus	X		X	
Potamogeton pusillus		X		
Potamogeton richardsonii	X		X	X
Potamogeton robbinsii	X	X	X	X
Ranunculus tricophyllus		X		X
Sagittaria spp	X	X	X	
Scirpus spp	X			
Typha spp	X			
Utricularia vulgaris		X		
Vallisneria americana		X		

APPENDIX 2

MACROPHYTE SPECIES PRESENT ON TRANSECTS IN MARMION LAKE NEAR ABIE IN 1986

TRANSECTS	1	2	3
Callitriche hermophroditica		X	
Chamoedaphne calyculata		X	
Chara sp	X		
Elodea canadensis	X	X	X
Juncus effusus		X	
Myriophyllum alterniflorus	X	X	X
Myriophyllum exalbescens	X	X	X
Najas flexilis	X	X	X
Nymphaea odorata	X		
Potamogeton amplifolius	X	X	
Potamogeton epihydrus	X	X	
Potamogeton gramineus		X	
Potamogeton richardsonii	X	X	X
Potamogeton robbinsii	X	X	X
Potamogeton zosteriformis	X	X	X
Sagittaria spp		X	X
Scirpus spp		X	

APPENDIX 2

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN MARMION LAKE AT ANDERSON DAM IN 1986

TRANSECT	1	2	3	4
Callitriche hermaphroditica	X	X	X	X
Ceratophyllum demersum	X	X	X	X
Chara sp	X	X	X	X
Eleocharis acicularis				X
Elodea canadensis	X	X	X	X
Glyceria borealis				X
Myriophyllum alterniflorus	X	X	X	X
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Nymphaea odorata	X	X	X	X
Potamogeton epihydrus	X	X	X	X
Potamogeton gramineus				X
Potamogeton praelongus	X	X	X	
Potamogeton pusillus	X	X	X	X
Potamogeton richardsonii	X	X		X
Potamogeton spirillus				X
Potamogeton zosteriformis	X	X	X	X
Ranunculus tricophyllus	X	X	X	X
Sagittaria spp				X
Scirpus spp				X
Typha spp				X

APPENDIX 3

Scientific and Common Names of Macrophytes cited in the text
(from Fassett 1975)

Scientific Name	Common Name
Beckmannia syzigachne	Slough Grass
Brasenia schreberi	Water Shield
Calamagrostis canadensis	Bluejoint
Callitriche hermaphrodite	Water Starwort
C. heterophylla	Water Starwort
Ceratophyllum demersum	Coontail
Chamaedaphne calyculata	Leatherleaf
Dulichium arundinaceum	Three-way Sedge
Eleocharis acicularis	Needle Rush
E. paulustris	Creeping Spike Rush
Elodea canadensis	Waterweed
Equisetum sp	Scouring Rush (Horsetail)
Eriocaulon septangulare	Pipewort
Glyceria borealis	Manna Grass
G. canadensis	Rattlesnake Manna Grass
G. grandis	Reed Meadow Grass
Hippurus vulgaris	Mare's Tail
Iris sp	Iris
Juncus effusus	Soft Rush
Lemna sp	Duckweed
Lobelia dortmonna	Water Lobelia
Megalodonta beckii	Water Marigold
Mimmulus ringens	Monkey Flower
Myriophyllum alterniflorus	Water Milfoil
M. exalbescens	Water Milfoil
Najas flexilis	Bushy Pondweed
Nuphar sp	Yellow Water Lily
Nymphaea odorata	Water Lily
Polygonum natans	Smartweed
Potamogeton alpinus	-
P. amplifolius	Large-leaf Pondweed (Muskie, Bass Weed)
P. epihydrus	Leafy Pondweed
P. foliosus	Leafy Pondweed
P. friesii	-
P. gramineus	Variable Pondweed
P. natans	Floating Brownleaf (Floating-leaf Pondweed)
P. obtusifolius	-
P. pectinatus	Sago Pondweed
P. praelongus	-
P. pusillus	-
P. richardsonii	Clasping-leafed Pondweed (Bass Weed)

P. robbinsii	Robbin's Pondweed
P. spirillus	-
P. strictifolius	-
P. vaseyi	-
P. zosteriformis	Flat-stemmed Pondweed
Ranunculus tricophyllus	Buttercup (Crowfoot)
Rorippa islandica	Cress
Sagittaria sp	Arrowhead (Duck Potato)
Scirpus cyperinus	Bulrush
S. validus	Softstem Bulrush (Great Bulrush)
Sium suave	Water Parsnip
Sparganium fluctuans	Floating-leaf Bur Reed (Broad Ribbon-leaf)
Typha spp	Cattail
Utricularia vulgaris	Bladderwort
Vallisneria americana	Wild Celery (Tape Grass)

LOCATION
SNOW
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	.	.	.	.	.	.	.	.	.	.	.
LAKE WHITEFISH	.	.	.	.	.	1.00	1.00	.	.	.	.
WHITE SUCKER	.	3.00	1.00	.	4.00	.	12.00	.	1.00	.	1.00
WALLEYE	.	.	.	.	.	.	.	.	.	.	.
NORTHERN PIKE	.	.	.	.	.	.	.	.	1.00	.	.
YELLOW PERCH	.	.	.	.	.	.	8.00	.	1.00	.	3.00
BURBOT	.	.	.	.	.	.	.	.	.	.	.
DURATION (hours)	2.00	2.50	2.50	3.00	3.00	2.00	2.00	2.50	3.00	3.50	3.00

LOCATION
ICY
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	.	.	.	.	1.00	2.00	.	.	2.00	.	.
LAKE WHITEFISH	.	.	9.00	1.00	.	.	.	.	.	1.00	.
WHITE SUCKER	1.00	.	8.00	3.00	1.00	1.00	.	.	.	.	.
WALLEYE	.	.	1.00	2.00	.	.	.	1.00	2.00	.	.
NORTHERN PIKE	1.00	.	1.00	1.00	.	3.00	1.00	.	1.00	2.00	.
YELLOW PERCH	8.00	.	.	.	.	.	.	.	1.00	2.00	.
BURBOT	.	.	.	.	.	.	.	.	.	.	.
DURATION (hours)	2.75	3.50	3.00	3.00	2.00	3.00	2.00	2.00	2.00	3.00	3.00

LOCATION
ABIE
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	.	1.00	1.00	7.00	2.00	2.00	.	.	.	.	.
LAKE WHITEFISH	.	.	.	4.00	1.00	3.00	.	1.00	.	.	1.00
WHITE SUCKER	.	3.00	.	2.00	.	.	1.00	.	.	.	1.00
WALLEYE	1.00	.	.	.	.	1.00	.	.	.	.	.
NORTHERN PIKE	.	2.00	2.00	.	.	1.00	.	.	1.00	2.00	2.00
YELLOW PERCH	.	.	.	.	.	.	.	.	.	.	.
BURBOT	.	.	.	.	.	.	.	.	.	.	.
DURATION (hours)	2.00	3.00	3.00	3.00	2.00	3.00	2.50	2.00	2.00	2.00	2.50

LOCATION
SLUSH
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	.	1.00	1.00	1.00	.	.	.	4.00	.	.	.
LAKE WHITEFISH	1.00	.	.	.	.	.	.	.	.	.	.
WHITE SUCKER	1.00	.	1.00	.	.	.	.	1.00	.	2.00	.
WALLEYE	.	.	.	.	.	.	.	.	.	.	.
NORTHERN PIKE	1.00	.	.	.	.	.	.	3.00	2.00	.	1.00
YELLOW PERCH	.	.	.	.	.	.	.	.	.	.	.
BURBOT	.	.	.	.	.	.	.	.	.	.	.
DURATION (hours)	2.00	3.50	2.00	3.00	2.50	2.00	2.00	3.00	3.00	3.50	3.00

LOCATION
M.SOUTH
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	2.00	1.00	.	.	2.00	12.00	15.00	3.00	2.00	1.00	.
LAKE WHITEFISH	.	.	1.00	12.00	6.00	16.00	6.00	4.00	2.00	4.00	.
WHITE SUCKER	.	4.00	.	2.00	.	.	.	7.00	.	2.00	.
WALLEYE	2.00	1.00	1.00	.	.	.	.	2.00	2.00	.	.
NORTHERN PIKE	.	.	2.00	1.00	.	.	.	.	.	1.00	1.00
YELLOW PERCH	1.00	.	.	.	.	.	.	.	.	.	.
BURBOT	.	.	.	.	.	.	.	.	.	.	.
DURATION (hours)	2.00	2.00	3.00	2.00	3.00	3.00	2.75	2.00	2.00	2.00	2.50

LOCATION
M.CENTRAL
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	7.00	28.00	17.00	3.00	46.00	27.00	7.00	36.00	5.00	14.00	11.00
LAKE WHITEFISH	13.00	12.00	40.00	7.00	25.00	10.00	9.00	3.00	1.00	2.00	2.00
WHITE SUCKER	5.00	7.00	3.00	4.00	7.00	18.00	6.00	8.00	11.00	24.00	6.00
WALLEYE	8.00	7.00	8.00	2.00	2.00	.	.	35.00	21.00	36.00	13.00
NORTHERN PIKE	.	5.00	11.00	6.00	8.00	3.00	.	5.00	4.00	3.00	5.00
YELLOW PERCH	.	1.00	.	.	2.00	.	6.00	.	.	.	.
BURBOT	3.00	1.00	.	.	.	.	1.00	.	1.00	.	.
DURATION (hours)	24.00	26.00	24.00	20.00	25.00	25.00	26.00	24.00	24.00	22.00	24.00

LOCATION
M.NORTH
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	1.00	2.00	14.00	32.00	42.00	9.00	3.00	.	.	109.00	6.00
LAKE WHITEFISH	7.00	.	.	21.00	15.00	11.00	.	.	1.00	4.00	9.00
WHITE SUCKER	15.00	.	.	.	.	.	.	.	.	.	1.00
WALLEYE	1.00	.	.	.	.	.	.	.	.	1.00	8.00
NORTHERN PIKE	2.00	2.00	1.00	1.00	.	.	2.00	.	.	1.00	3.00
YELLOW PERCH	.	.	.	.	.	.	.	.	.	.	.
BURBOT	3.00	.	2.00	.	.	.	.	.	.	1.00	.
DURATION (hours)	24.00	24.00	24.00	20.00	20.00	24.00	26.00	22.00	24.00	19.00	24.00

APPENDIX 4 - GILLNET CATCH, ATIKOKAN 1986

LOCATION
ANDERSON DAM
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	.	.	2.00	1.00	3.00	3.00	.	.	1.00	.	1.00
LAKE WHITEFISH	.	.	3.00	1.00	3.00	1.00	.	.	.	2.00	1.00
WHITE SUCKER	.	.	7.00	6.00	3.00	2.00	.	3.00	1.00	3.00	1.00
WALLEYE	.	.	1.00	.	1.00	.	.	.	.	1.00	1.00
NORTHERN PIKE	.	3.00	7.00	.	6.00	.	.	.	.	4.00	1.00
YELLOW PERCH	3.00	.	.	1.00	1.00	1.00	1.00	.	.	.	.
BURBOT	.	.	.	.	.	.	.	.	.	.	.
DURATION (hours)	2.00	2.50	5.00	2.00	2.00	2.50	2.00	2.50	2.00	2.00	3.00

LOCATION
LOWER SEINE
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	33.00	5.00	7.00	31.00	44.00	49.00	44.00	15.00	23.00	21.00	2.00
LAKE WHITEFISH	2.00	11.00	22.00	42.00	14.00	41.00	36.00	12.00	18.00	5.00	6.00
WHITE SUCKER	.	8.00	1.00	2.00	.	1.00	.	.	.	2.00	2.00
WALLEYE	5.00	16.00	1.00	2.00	2.00	.	.	1.00	1.00	10.00	5.00
NORTHERN PIKE	1.00	.	7.00	2.00	.	1.00	1.00	1.00	1.00	1.00	3.00
YELLOW PERCH	5.00	.	.	.	.	.	.	.	.	.	.
BURBOT	1.00	.	1.00	.	.	1.00	.	.	.	.	2.00
DURATION (hours)	24.00	25.00	24.00	23.00	22.00	21.00	26.00	22.00	24.00	24.00	24.00

LOCATION
MOOSE
CATCH

	DATE										
	APR 25-30	MAY 8-13	MAY 21-25	JUN 3-6	JUN 9-12	JUL 12-15	AUG 6-11	SEP 9-13	SEP 15-18	OCT 16-19	OCT 21-24
SPECIES											
CISCO	.	.	.	.	.	.	2.00	.	.	.	.
LAKE WHITEFISH	.	.	.	.	2.00	.	1.00	.	.	1.00	.
WHITE SUCKER	.	.	.	.	.	.	.	.	.	.	.
WALLEYE	.	.	.	.	.	.	.	.	.	.	.
NORTHERN PIKE	.	.	3.00	1.00	.	.	.	.	.	.	1.00
YELLOW PERCH	.	.	.	.	.	.	.	.	.	.	.
BURBOT	.	.	.	.	.	.	.	.	.	.	.
DURATION (hours)	2.00	2.00	5.00	2.00	2.00	2.50	2.00	2.50	2.00	2.00	2.00

LOCATION
SNOW LAKE
CATCH

	DATE													
	EARLY MAY			LATE MAY			EARLY JUN			LATE JUN			JUL	
	REP			REP			REP			REP			REP	
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00
SPECIES														
IOWA DARTER	8.00	7.00	4.00	.	2.00	6.00	.	.	3.00	2.00	5.00	.	1.00	.
SPOTTAIL SHINER	4.00	4.00	1.00	.	.	.	.	.	.	.	.	.	.	.
BLACKNOSE SHINER	61.00	68.00	4.00	.	.	.	.	.	.	2.00	.	2.00	.	.
MIMIC SHINER	67.00	75.00	10.00	.	.	.	.	.	.	12.00	.	2.00	.	.
YELLOW PERCH	62.00	110.00	.	.	.	.	158.00	262.00	7.00	68.00	7.00	62.00	3.00	66.00
WHITE SUCKER	.	3.00	.	.	.	.	.	.	.	.	.	.	.	.
GOLDEN SHINER	1.00	.	.	.	.	.	.	.	.	.	.	.	.	.
FATHEAD MINNOW	2.00	.	.	.	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	.	1.00	.	1.00	.	.	.	.	.	.	.	.
CISCO	.	.	.	.	.	.	.	.	.	.	.	.	1.00	.

	DATE												DATE	DATE
	JUL	AUG			EARLY SEP			LATE SEP			EARLY OCT			LATE OCT	LATE OCT
	REP	REP			REP			REP			REP			REP	REP
	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	3.00
SPECIES															
IOWA DARTER	.	.	5.00	2.00	.	.	.	.	3.00	.	.	6.00	.	1.00	1.00
SPOTTAIL SHINER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BLACKNOSE SHINER	.	.	.	.	120.00	120.00	60.00	9.00	27.00	15.00	.	.	.	.	.
MIMIC SHINER	.	.	18.00	.	.	.	.	.	.	.	.	.	.	.	.
YELLOW PERCH	44.00	1.00	14.00	13.00	1740.00	1080.00	1640.00	228.00	228.00	183.00	165.00	224.00	219.00	1.00	.
WHITE SUCKER	.	.	.	.	20.00	.	.	.	.	.	.	.	.	3.00	.
GOLDEN SHINER	.	.	.	.	.	20.00	40.00	.	6.00	.	.	.	.	1.00	.
FATHEAD MINNOW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CISCO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

LOCATION
ICY LAKE
CATCH

	DATE													
	EARLY MAY			LATE MAY			EARLY JUN			LATE JUN			JUL	
	REP			REP			REP			REP			REP	
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00
SPECIES														
IOWA DARTER	6.00	16.00	2.00	3.00	2.00	.	9.00	6.00	3.00	1.00	2.00	10.00	.	2.00
SPOTTAIL SHINER	11.00	11.00	1.00	.	11.00	.	.	.	.	.	.	.	.	2.00
BLACKNOSE SHINER	74.00	152.00	.	3.00	1.00	.	74.00	51.00	69.00	27.00	12.00	32.00	51.00	27.00
MIMIC SHINER	16.00	.	.	14.00	.	2.00	.	.	.	2.00	.	2.00	.	.
YELLOW PERCH	3.00	3.00	.	.	59.00	1.00	60.00	39.00	57.00	30.00	26.00	22.00	8.00	25.00
WHITE SUCKER	.	.	.	1.00	.	.	.	.	.	.	.	.	.	54.00
GOLDEN SHINER	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FATHEAD MINNOW	.	.	.	5.00	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SLIMY SCULPIN	.	.	1.00	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	3.00	.	1.00	5.00	35.00	1.00	99.00	51.00	66.00	30.00	26.00	20.00	2.00	.
LONGNOSE DACE	2.00	.	.	.	.	.	.	.	.	.	.	.	.	.
PEDPELLY DACE	.	.	.	1.00	.	.	.	.	.	.	.	.	.	.
WALLEYE	.	.	.	.	3.00	1.00	.	.	.	.	.	.	.	.

	DATE														
	JUL	AUG			EARLY SEP			LATE SEP			EARLY OCT			LATE OCT	
	REP	REP			REP			REP			REP			REP	REP
	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
SPECIES																
IOWA DARTER	.	8.00	5.00	5.00	5.00	13.00	5.00	5.00	5.00	2.00	9.00	6.00	15.00	9.00	3.00	.
SPOTTAIL SHINER	.	5.00	9.00	2.00	2.00	1.00	5.00	.	1.00	5.00	15.00	15.00	9.00	.	.	.
BLACKNOSE SHINER	27.00	36.00	.	2.00	17.00	.	.	5.00	21.00	2.00	12.00	12.00	15.00	15.00	21.00	6.00
MIMIC SHINER	3.00	.	.	.	.	.	.	.	.	.	.	.	.	3.00	.	.
YELLOW PERCH	21.00	5.00	3.00	3.00	3.00	9.00	.	2.00	15.00	1.00	459.00	477.00	399.00	519.00	405.00	405.00
WHITE SUCKER	27.00	2.00	17.00	10.00	56.00	4.00	3.00	1.00	23.00	16.00	6.00	24.00	24.00	9.00	9.00	3.00
GOLDEN SHINER	.	.	.	1.00	.	.	.	.	2.00	.	.	.	.	.	.	3.00
FATHEAD MINNOW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	6.00	.	3.00	.	.	.
SLIMY SCULPIN	.	.	.	.	.	1.00	1.00	.	.	.	.	3.00	.	.	.	.
LOGPERCH	.	4.00	2.00	6.00	2.00	16.00	5.00	.	4.00	1.00	.	.	.	.	.	.
LONGNOSE DACE	.	.	.	.	.	.	.	.	.	1.00	.	.	.	.	.	.
PEDPELLY DACE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WALLEYE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

LOCATION
ABIE LAKE
CATCH

	DATE													
	EARLY MAY			LATE MAY			EARLY JUN			LATE JUN			JUL	
	REP			REP			REP			REP			REP	
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00
SPECIES														
IOWA DARTER	6.00	5.00	1.00	.	.	3.00	.	.	1.00	.	10.00	5.00	3.00	6.00
SPOTTAIL SHINER	.	.	.	1.00	.	.	.	.	.	17.00	50.00	20.00	.	.
BLACKNOSE SHINER	.	.	.	1.00	3.00	10.00	47.00	3.00	56.00	688.00	420.00	915.00	234.00	240.00
MIMIC SHINER	.	.	.	1.00	.	6.00	.	.	1.00	250.00	215.00	255.00	6.00	.
YELLOW PERCH	1.00	11.00	1.00	.	5.00	27.00	4.00	.	11.00	33.00	40.00	40.00	39.00	33.00
WHITE SUCKER	.	.	.	.	.	.	.	.	1.00	.	.	5.00	63.00	75.00
GOLDEN SHINER	.	.	.	.	.	1.00	.	.	.	10.00	.	5.00	.	.
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CISCO	.	.	.	.	.	.	2.00	.	.	.	.	.	.	.
SLIMY SCULPIN	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	.	.	.	.	1.00	11.00	4.00	.	2.00	3.00	.	.	9.00	9.00
LONGNOSE.DACE	.	.	.	.	.	.	.	.	.	3.00	.	.	.	.
REDBELLY DACE	.	.	.	.	.	.	.	.	1.00	.	.	.	.	.
LAKE CHUB	.	.	.	.	.	6.00	.	.	.	3.00	10.00	.	6.00	6.00

	DATE													DATE
	JUL	AUG			EARLY SEP			LATE SEP			EARLY OCT			LATE OCT	LATE OCT
	REP	REP			REP			REP			REP			REP	REP
	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00
SPECIES															
IOWA DARTER	3.00	6.00	2.00	.	.	.	.	.	1.00	1.00	1.00	2.00	2.00	.	.
SPOTTAIL SHINER	.	.	1.00	.	.	10.00	16.00	1.00	9.00	2.00	.	.	.	.	.
BLACKNOSE SHINER	132.00	1.00	2.00	.	.	1.00	2.00	.	2.00	1.00	.	.	.	.	1.00
MIMIC SHINER	3.00	.	1.00	.	.	.	.	.	.	.	.	.	.	.	.
YELLOW PERCH	12.00	11.00	9.00	9.00	4.00	16.00	8.00	4.00	7.00	8.00	2.00	6.00	.	6.00	37.00
WHITE SUCKER	15.00	.	.	.	.	.	.	.	.	2.00	.	.	.	.	.
GOLDEN SHINER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	3.00	.	.	.	4.00	.	.	1.00	.	.	.	.	.	.	.
CISCO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SLIMY SCULPIN	.	.	.	.	.	1.00	.	.	.	.	.	.	.	.	.
LOGPERCH	9.00	3.00	2.00	1.00	.	2.00	3.00	3.00	.	2.00	.	.	.	.	.
LONGNOSE.DACE	3.00	.	.	.	.	.	.	.	.	.	.	.	.	.	.
REDBELLY DACE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LAKE CHUB	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

LOCATION
SLUSH LAKE
CATCH

	DATE													
	EARLY MAY			LATE MAY			EARLY JUN	LATE JUN			JUL			AUG
	REP			REP			REP	REP			REP			REP
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00
SPECIES														
IOWA DARTER	1.00	.	.	10.00	10.00	.	.	.	.	.	.	.	.	.
NORTHERN PIKE	.	.	.	.	.	.	.	.	.	.	.	1.00	.	.
BLACKNOSE SHINER	.	.	.	850.00	1540.00	710.00	.	105.00	55.00	48.00	17.00	3.00	1.00	.
MIMIC SHINER	.	.	.	.	.	.	.	.	.	.	1.00	.	.	.
YELLOW PERCH	2.00	1.00	1.00	240.00	270.00	350.00	1.00	270.00	215.00	116.00	1.00	1.00	.	1.00

	DATE							
	AUG		EARLY SEP			EARLY OCT		
	REP		REP			REP		
	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
SPECIES								
IOWA DARTER	.	.	1.00	.	.	.	.	.
NORTHERN PIKE	.	.	.	.	.	.	.	.
BLACKNOSE SHINER	.	.	20.00	2.00	6.00	.	.	.
MIMIC SHINER	.	.	.	.	.	.	.	.
YELLOW PERCH	3.00	4.00	.	.	.	10.00	8.00	10.00

LOCATION
MARMION SOUTH
CATCH

	DATE													
	EARLY MAY	LATE MAY			EARLY JUN			LATE JUN			JUL			AUG
	REP	REP			REP			REP			REP			REP
	1.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00
SPECIES														
IOWA DARTER	6.00	.	.	.	.	.	.	.	.	.	.	.	2.00	.
SPOTTAIL SHINER	.	4.00	3.00	6.00	.	20.00	.	.	.	.	.	.	.	1.00
BLACKNOSE SHINER	1.00	15.00	2.00	2.00	140.00	300.00	230.00	164.00	204.00	348.00	18.00	17.00	9.00	3.00
MIMIC SHINER	.	14.00	7.00	9.00	20.00	80.00	100.00	8.00	18.00	12.00	.	.	.	.
YELLOW PERCH	.	25.00	237.00	34.00	340.00	460.00	300.00	48.00	32.00	64.00	18.00	11.00	9.00	3.00
WHITE SUCKER	.	.	1.00	.	60.00	20.00	10.00	.	.	.	.	.	2.00	.
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	1.00	.	.	.	.	.	.	.	.	.	.	.	.	.
WALLEYE	.	.	.	.	20.00	.	10.00	.	.	.	.	.	.	.

	DATE												
	AUG	EARLY SEP			LATE SEP			EARLY OCT			LATE OCT		
	REP	REP			REP			REP			REP		
	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
SPECIES														
IOWA DARTER	5.00	.	12.00	8.00	9.00	1.00	2.00	.	1.00	.	.	3.00	.	.
SPOTTAIL SHINER	5.00	2.00	.	.	.	.	.	.	.	.	.	.	.	3.00
BLACKNOSE SHINER	7.00	.	4.00	3.00	9.00	1.00	3.00	.	.	6.00	5.00	.	.	.
MIMIC SHINER	1.00	1.00	.	.	.	.	.	.	.	.	.	.	.	.
YELLOW PERCH	15.00	5.00	41.00	1.00	34.00	25.00	6.00	15.00	20.00	18.00	31.00	123.00	102.00	144.00
WHITE SUCKER	.	.	19.00	.	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	.	.	.	.	1.00	.	1.00	.	.	3.00	.	.
LOGPERCH	1.00	.	.	.	.	.	.	.	.	.	.	.	.	.
WALLEYE	.	.	.	.	.	.	.	.	.	.	.	.	.	.

LOCATION
MARMION CENTRAL
CATCH

	DATE													
	EARLY MAY			LATE MAY			EARLY JUN			LATE JUN	JUL			AUG
	REP			REP			REP			REP	REP			REP
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	1.00	2.00	3.00	1.00
SPECIES														
IOWA DARTER	.	1.00	.	.	.	.	.	.	.	.	.	3.00	.	6.00
SPOTTAIL SHINER	.	.	.	1.00	.	.	.	.	.	.	.	.	.	.
BLACKNOSE SHINER	2.00	3.00	.	72.00	8.00	35.00	9.00	12.00	.	3.00	.	.	.	3.00
MIMIC SHINER	.	.	.	15.00	2.00	3.00	.	2.00	17.00	.	6.00	5.00	.	1.00
YELLOW PERCH	.	.	.	18.00	36.00	34.00	5.00	4.00	.	.	30.00	34.00	36.00	2.00
WHITE SUCKER	.	.	.	.	.	.	.	.	.	.	78.00	57.00	120.00	3.00
GOLDEN SHINER	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FATHEAD MINNOW	.	.	.	8.00	1.00	2.00	.	.	.	.	.	.	.	2.00
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SLIMY SCULPIN	.	.	.	.	.	.	.	.	1.00	.	.	.	.	.
LOGPERCH	.	.	4.00	.	.	.	.	.	.	.	.	.	.	.

	DATE												
	AUG	EARLY SEP			LATE SEP			EARLY OCT		LATE OCT			
	REP	REP			REP			REP		REP			
	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	3.00	1.00	2.00	3.00
SPECIES													
IOWA DARTER	4.00	6.00	.	.	.	.	.	.	1.00	1.00	.	1.00	.
SPOTTAIL SHINER	.	.	.	3.00	3.00	.	.	.	.	.	.	.	.
BLACKNOSE SHINER	.	3.00	69.00	30.00	51.00	4.00	2.00	4.00	.	.	1.00	1.00	.
MIMIC SHINER	.	.	12.00	.	9.00	.	.	.	.	1.00	.	.	.
YELLOW PERCH	2.00	.	.	.	.	.	6.00	8.00	.	1.00	1.00	.	.
WHITE SUCKER	3.00	1.00	.	.	.	.	.	.	.	.	.	.	.
GOLDEN SHINER	.	.	6.00	.	3.00	.	.	.	.	.	.	.	.
FATHEAD MINNOW	.	5.00	3.00	6.00	3.00	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	324.00	147.00	237.00	15.00	14.00	10.00	1.00	1.00	.	.	1.00
SLIMY SCULPIN	.	.	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	.	.	.	.	.	.	.	.	.	.	.	.	.

LOCATION
MARMION NORTH
CATCH

	DATE													
	EARLY MAY			LATE MAY		EARLY JUN			LATE JUN	JUL			AUG	
	REP			REP		REP			REP	REP			REP	
	1.00	2.00	3.00	1.00	3.00	1.00	2.00	3.00	1.00	1.00	2.00	3.00	1.00	2.00
SPECIES														
IOWA DARTER	5.00	2.00	3.00	2.00	2.00	1.00	.	.	.	6.00	3.00	3.00	.	.
SPOTTAIL SHINER	2.00	.	.	.	.	.	.	.	.	.	.	.	36.00	30.00
BLACKNOSE SHINER	2.00	2.00	2.00	.	.	12.00	28.00	34.00	1.00	.	.	.	15.00	6.00
MIMIC SHINER	.	.	.	.	.	92.00	7.00	10.00	.	.	.	3.00	168.00	213.00
YELLOW PERCH	.	.	.	.	.	1.00	6.00	1.00	.	927.00	693.00	612.00	336.00	276.00
WHITE SUCKER	.	.	.	1.00	.	.	.	.	.	108.00	104.00	66.00	33.00	30.00
GOLDEN SHINER	.	.	.	.	.	1.00	.	.	.	.	.	.	.	.
FATHEAD MINNOW	.	.	.	.	.	12.00	3.00	1.00	.	.	.	.	.	.
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SLIMY SCULPIN	.	1.00	.	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	.	.	.	.	.	.	1.00	2.00	.	3.00	.	.	9.00	12.00
WALLEYE	.	.	.	.	.	.	.	.	.	.	.	3.00	.	.
BLUNTNOSE MINNOW	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	DATE												
	AUG	EARLY SEP			LATE SEP			EARLY OCT			LATE OCT		
	REP	REP			REP			REP			REP		
	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
SPECIES													
IOWA DARTER	3.00	.	4.00	1.00	.	.	1.00	.	3.00	4.00	.	.	.
SPOTTAIL SHINER	21.00	.	.	.	.	.	13.00	.	.	.	.	.	.
BLACKNOSE SHINER	9.00	4.00	4.00	4.00	.	.	.	.	1.00	.	3.00	9.00	3.00
MIMIC SHINER	270.00	.	.	.	.	.	1.00	.	.	.	.	.	.
YELLOW PERCH	357.00	22.00	1.00	3.00	39.00	43.00	1.00	2.00	.	15.00	306.00	210.00	369.00
WHITE SUCKER	27.00	3.00	1.00	.	.	.	.	.	.	.	.	.	.
GOLDEN SHINER	.	.	.	.	.	.	.	.	.	.	.	.	.
FATHEAD MINNOW	.	.	.	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	1.00	.	.	.	.	.	.	.	.	.	.
SLIMY SCULPIN	.	.	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	3.00	.	.	.	.	1.00	1.00	.	.	.	.	.	.
WALLEYE	.	.	.	.	.	.	.	.	.	.	.	.	.
BLUNTNOSE MINNOW	3.00	.	.	.	.	.	.	.	.	.	.	.	.

LOCATION
ANDERSON DAM
CATCH

	DATE													
	EARLY MAY			LATE MAY			EARLY JUN			LATE JUN			JUL	
	REP			REP			REP			REP			REP	
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00
SPECIES														
IOWA DARTER	1.00	3.00	2.00	.	.	.	2.00	.	2.00	.	.	1.00	.	.
SPOTTAIL SHINER	.	.	.	1.00	.	.	.	.	.	.	.	.	.	.
BLACKNOSE SHINER	.	.	.	15.00	.	18.00	2.00	.	.	1.00	2.00	3.00	3.00	3.00
MIMIC SHINER	.	.	.	1.00	.	.	.	.	1.00	.	2.00	.	516.00	501.00
YELLOW PERCH	.	.	.	.	.	1.00	1.00	.	.	.	.	.	9.00	9.00
WHITE SUCKER	.	.	2.00	.	.	.	1.00	.	.	.	.	.	948.00	762.00
GOLDEN SHINER	.	.	.	.	.	.	.	.	1.00	.	.	.	.	.
LOGPERCH	.	.	.	.	1.00	1.00	36.00	1.00	.	2.00	2.00	1.00	.	3.00
TROUT PERCH	.	.	.	.	.	.	.	.	.	1.00	.	.	.	.
CYPRINIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	DATE										
	JUL	AUG			EARLY SEP			LATE SEP		LATE OCT	
	REP	REP			REP			REP		REP	
	3.00	1.00	2.00	3.00	1.00	2.00	3.00	2.00	3.00	1.00	2.00
SPECIES											
IOWA DARTER	3.00	.	2.00	.	.	.	.	.	.	2.00	1.00
SPOTTAIL SHINER	.	.	.	3.00	.	.	.	.	.	.	.
BLACKNOSE SHINER	12.00	.	.	3.00	6.00	11.00	3.00	.	.	1.00	2.00
MIMIC SHINER	507.00	.	3.00	39.00	.	.	.	.	.	.	.
YELLOW PERCH	18.00	12.00	6.00	7.00	3.00	11.00	2.00	3.00	13.00	.	.
WHITE SUCKER	1194.00	4.00	12.00	51.00	.	.	.	.	.	.	.
GOLDEN SHINER	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	.	6.00	6.00	12.00	5.00	11.00	1.00	.	.	.	.
TROUT PERCH	.	.	.	.	.	.	.	.	.	.	.
CYPRINIDAE	.	2.00	.	.	.	.	.	.	.	.	.

LOCATION
LOWER SEINE
CATCH

	DATE													
	EARLY MAY			LATE MAY			EARLY JUN			LATE JUN			JUL	
	REP			REP			REP			REP			REP	
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00
SPECIES														
IOWA DARTER	47.00	61.00	52.00	1.00	13.00	6.00	3.00	3.00	3.00	13.00	4.00	2.00	2.00	5.00
SPOTTAIL SHINER	.	.	.	.	.	.	9.00	.	.	.	.	.	.	.
BLACKNOSE SHINER	.	1.00	.	3.00	.	1.00	78.00	78.00	36.00	11.00	1.00	.	22.00	18.00
MIMIC SHINER	.	.	.	.	1.00	1.00	804.00	1107.00	624.00	.	.	.	21.00	18.00
YELLOW PERCH	22.00	1.00	.	.	13.00	6.00	6.00	3.00	3.00	7.00	12.00	6.00	8.00	14.00
WHITE SUCKER	.	.	.	.	.	.	.	.	.	.	.	.	44.00	78.00
GOLDEN SHINER	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FATHEAD MINNOW	.	.	.	.	.	.	.	12.00	6.00	.	.	.	.	.
PUMPKINSEED	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	2.00	.	.	.	.	.	.	.	.	.	1.00	3.00	.	.

	DATE														
	JUL	AUG			EARLY SEP			LATE SEP		EARLY OCT			LATE OCT		
	REP	REP			REP			REP		REP			REP		REP
	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	1.00	2.00	3.00	1.00	2.00	3.00
SPECIES															
IOWA DARTER	.	.	.	.	2.00	3.00	1.00	3.00	10.00	2.00	4.00	3.00	2.00	6.00	4.00
SPOTTAIL SHINER	.	.	1.00	8.00	.	.	.	.	.	.	.	.	.	.	.
BLACKNOSE SHINER	10.00	1.00	.	1.00	.	.	15.00	2.00	8.00	1.00	.	.	.	.	.
MIMIC SHINER	7.00	8.00	29.00	.	.	.	.	.	.	.	.	.	.	.	.
YELLOW PERCH	9.00	18.00	6.00	7.00	2.00	14.00	25.00	3.00	1.00	.	.	2.00	1.00	.	.
WHITE SUCKER	69.00	6.00	.	4.00	.	.	.	.	.	.	.	.	.	.	.
GOLDEN SHINER	.	.	1.00	6.00	.	.	.	.	.	.	.	.	.	.	.
FATHEAD MINNOW	1.00	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PUMPKINSEED	.	.	.	1.00	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	.	3.00	.	.	.	.	.	.	.	.	.	.	.	.	.

LOCATION
MOOSE LAKE
CATCH

	DATE														
	EARLY MAY			LATE MAY		EARLY JUN			LATE JUN			JUL			
	REP			REP		REP			REP			REP			
	1.00	2.00	3.00	1.00	2.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	
SPECIES															
IOWA DARTER	12.00	13.00	11.00	1.00	.	1.00	.	.	1.00	1.00	1.00	6.00	.	.	
SPOTTAIL SHINER	12.00	.	.	.	.	.	.	.	.	.	.	.	.	.	
BLACKNOSE SHINER	7.00	1.00	.	.	.	.	.	3.00	.	.	.	.	.	.	
MIMIC SHINER	.	.	.	.	.	42.00	26.00	57.00	.	.	.	45.00	30.00	48.00	
YELLOW PERCH	.	.	1.00	.	.	.	.	.	.	.	.	285.00	153.00	279.00	
WHITE SUCKER	.	.	.	.	.	.	.	.	34.00	38.00	47.00	.	.	.	
GOLDEN SHINER	.	.	.	.	.	.	.	1.00	.	.	.	.	.	.	
CISCO	8.00	.	.	.	2.00	.	.	.	.	.	.	.	.	.	
LOGPERCH	4.00	.	.	.	.	.	.	.	.	.	.	.	.	.	
LAKE WHITEFISH	12.00	.	.	.	.	.	.	.	.	.	.	.	.	.	

	DATE														
	AUG			EARLY SEP			LATE SEP			EARLY OCT			LATE OCT		
	REP			REP			REP			REP			REP		REP
	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
SPECIES															
IOWA DARTER	1.00	1.00	.	1.00	.	.	.	.	.	.	.	.	2.00	5.00	.
SPOTTAIL SHINER	5.00	6.00	9.00	2.00	.	7.00	3.00	1.00	.	.	2.00	.	.	.	.
BLACKNOSE SHINER	5.00	1.00	3.00	2.00	.	1.00	1.00	.	1.00	.	.	.	20.00	5.00	34.00
MIMIC SHINER	27.00	54.00	51.00	8.00	1.00	9.00	5.00	4.00	2.00	.	.	.	.	.	.
YELLOW PERCH	111.00	150.00	132.00	23.00	1.00	8.00	29.00	50.00	34.00	1.00	3.00	3.00	13.00	8.00	22.00
WHITE SUCKER	12.00	9.00	.00	.	.	2.00	.	.	.	.	.	.	.	.	.
GOLDEN SHINER	.	.	.	.	.	.	.	.	.	1.00	1.00	.	.	.	.
CISCO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LOGPERCH	.	.	2.00	.	.	.	.	.	.	.	.	.	.	.	.
LAKE WHITEFISH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

APPENDIX 6

CATCH IN LARVAL TOW NETS ATIKOKAN - 1986

Snow Lake	April 30				May 12				May 21				June 3				June 9				July 12				July 16			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Yellow Perch									3	3	17	13	18	29	26	8		10	6		3	5	1	10				
Cyprinidae																		3	1		2	2	1	2				
Pumpkinseed																					9	81	12	42			3	15
9-Spine Stickleback																												1

Icy Lake	May 8				May 22					June 4					June 9				July 12				July 17			
	1	2	3	4	1	2	3	4	5[1]	1	2	3	4	5[1]	1	2	3	4	1	2	3	4	1	2	3	4
Walleye Eggs			3	6	2	3																				
Yellow Perch					2	1	2	7														2	2	12	1	
Walleye						1																				
White Sucker										1		4	2				1	11			2	4				
Logperch										6		1					6									
Iowa Darter												1														
Cyprinid Eggs														7												
Cyrpinidae																			11	3	1	7	7		11	12
Pumpkinseed																			49	11	2	14	1	13	21	17

Abie Lake	May 8				May 22					June 4					June 9				July 12				July 17			
	1	2	3	4	1	2	3	4	5[1]	1	2	3	4	5[2]	1	2	3	4	1	2	3	4	1	2	3	4
Yellow Perch					25	19	6	2			1	9	2						5	3	2	1	2			
White Sucker						1				63	4	20	1	465	72	7					5	14		1		
Logperch													1	1			10	1								
Cyprinidae														1					1	5	72	34		2	28	9
Pumpkinseed																			37	16	214	22	8	8	12	14
Spottail Shiner																					2					

Appendix 6 (Cont'd)

Anderson Dam	April 29		May 13		May 23		June 4		June 11		July 12		July 17	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Lake Whitefish			2											
Burbot				1										
Yellow Perch					17	5	35	22	2	30	9	4		1
Cisco	1													
Cyprinidae									1	1	4	4	4	4
White Sucker									1	1				
Pumpkinseed											4	1		2
Unidentified											1			
Pumpkinseed Eggs														2

Lower Seine			May 8		May 23		June 4		June 11		July 12		July 16	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Burbot			1	1										
Yellow Perch					10	7	37	34	1	11	1	2		1
White Sucker							1	4			1			
Cyprinidae										1	9	2		3
Pumpkinseed											18	4		16

Moose Lake	April 29				May 13				May 23				June 4				June 11				July 12				July 17			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Cisco	19	6	1	4		2	2	1																				
Walleye									1																			
Yellow Perch									17	18	6	26	9	12	67	13				1	4		6	6			1	1
Lake Whitefish			2																									
White Sucker																	17	31	231	141								
Cyprinidae																	3	2	3		4	2	7	3	1	3	1	3
Logperch																			1	6								
Pumpkinseed																												3

Appendix 6 (Cont'd)

Slush Lake	May 11		May 21		June 3		June 9		July 12		July 17	
	1	2	1	2	1	2	1	2	1	2	1	2
Lake Whitefish	1	6										
Yellow Perch			20	20	11	4		3	13	7		
Cyprinidae									2		5	1
Unidentified							5	1				
Pumpkinseed											2	

Marmion South	May 8				May 22				June 4				June 11				July 12				July 17			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Burbot				3																				
Lake Whitefish					1																			
Yellow Perch					3	1	2	1	3		20	2		15		16		2	2			1		
White Sucker									2	59	1	9	1	1								1		
Logperch									7		1													
Walleye													1											
Pumpkinseed																	7	1	4	3	2	11	10	22
Cyprinidae																	7	4	16	3		8	19	20
Golden Shiner																					1			

Marmion Central	May 8		May 23		June 4		June 11		July 12		July 17	
	1	2	1	2	1	2	1	2	1	2	1	2
Yellow Perch			1	3	5	13	2	26	15	16	2	16
Lake Whitefish			1									
White Sucker							12					
Cyprinidae									5	5	1	5
Pumpkinseed									3	1	3	10

Marmion North	April 29		May 12		May 22		June 4		June 11		July 12		July 17	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Yellow Perch							22	33	16	42	19	19	1	2
White Sucker							1				1			
Logperch							1							
Pumpkinseed											23	12	7	9
Cyprinidae											1	2	6	8
Golden Shiner														4

APPENDIX 7

RESULTS OF DRIFT SAMPLING WITH PLANKTON NETS - ATIKOKAN 1986

Snow Lake Outlet

	May 8			May 11			May 13			May 15			May 22		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
White Sucker Eggs		11	1		4	3	68	127	45	1	4	1			

Icy Lake Outlet

	May 8			May 11			May 13			May 15			May 22		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
White Sucker Eggs										470	16	12			

Ski Lake Outlet

	May 8			May 11			May 13			May 15			May 22		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
White Sucker Eggs	63	291	40	356	1,960	119		569	146	221	156			6	
Logperch											1				

Abie Lake Outlet

	May 8			May 11			May 13			May 15			May 22		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Walleye Egg		1													
Decayed Larval Fish														1	

Anderson Dam Channel

	May 11			May 12			May 13			May 15			May 22		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
White Sucker Egg														1	1

* Sample bottle broken

APPENDIX 8

RESULTS OF DRIFT SAMPLING WITH LARVAL TOW NETS - 1986

Snow Lake Outlet

	April 29	May 12	June 4	June 11	July 14
White Sucker	29				
White Sucker Eggs	39	212			
Walleye	1				
Walleye Eggs	80				
Yellow Perch			11	15	
Cyprinid Eggs				24	1
Decayed Larvae					2

Spillway Dam

	April 29	May 13	May 23	June 12	July 13
Walleye Eggs	156				
Lake Whitefish	1				
White Sucker Eggs		19	17,000		
Yellow Perch				2	
9-Spine Stickleback				2	
Cyprinid Eggs				72	

APPENDIX 9

RESULTS OF ENTRAINMENT SAMPLING - 1986

Date	Duration	Catch		Zero Catches Date	Duration
April 30	24h	White Sucker Larvae	-1	May 7	24h
	6h	Percid Eggs	-52	8	24h
	6h	Percid Eggs	-1		6h
May 1	12h	Coregonid Larvae	-1	9	12h
		Yellow Perch Adult	-1		24h
	24h	White Sucker Eggs	-1	13	24h
May 8	6h	Percid Eggs	-1	14	24h
May 24	24h	White Sucker Larvae	-1		6h
June 4	24h	Slimy Sculpin Adult	-1		6h
June 5	6h	Slimy Sculpin Adult	-1	15	12h
		9-Spine Stickleback Larvae	-2		24h
June 10	6h	White Sucker Eggs	-1	21	6h
	6h	Yellow Perch Larvae	-1		6h
June 12	24h	Yellow Perch Larvae	-1	22	12h
July 14	24h	Yellow Perch Adults	-5	23	24h
	6h	Yellow Perch Adults	-5	24	24h
	18h	Yellow Perch Adults	-13	June 4	6h
July 15	6h	Yellow Perch Adults	-12	5	24h
					6h
					6h
				6	24h
				10	24h
					6h
				11	24h
					6h
				July 13	24h
				15	18h

(C98)

APPENDIX 10
MEAN, MAXIMUM AND MINIMUM HOURLY TEMPERATURES
AT THE SNOW LAKE OUTLET, MARCH-MAY, 1986
(from G&HE Dept)

	MARCH			APRIL			MAY		
DATE	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN
1				3.0	3.7	2.4	6.6	7.8	6.1
2				3.1	3.6	2.8	7.5	9.0	6.7
3				3.9	4.6	3.7	7.8	8.6	7.2
4				4.0	4.7	3.6	8.1	9.1	7.4
5				3.2	3.4	3.1	8.2	9.5	7.4
6	3.4	4.6	2.1	3.2	3.6	2.9	9.8	10.9	9.0
7	3.3	4.4	2.4	3.2	3.6	2.9	9.7	10.6	9.1
8	3.5	4.6	2.9	3.0	3.1	2.8	10.2	10.9	9.7
9	2.7	3.1	2.3	3.0	3.4	2.6	10.3	11.1	9.9
10	2.2	2.6	2.0	3.8	4.9	3.1	10.6	11.1	10.2
11	2.5	3.1	2.0	4.7	5.7	3.9	9.8	10.2	9.5
12	3.2	3.4	2.8	5.0	5.4	4.4	10.2	11.6	9.3
13	3.3	3.6	3.1	4.9	5.2	4.7	12.2	13.6	10.7
14	3.3	3.6	3.2	4.8	5.9	4.4	13.5	14.7	12.0
15	3.4	3.7	3.1	5.8	7.4	5.2	13.9	15.3	12.5
16	2.8	3.1	2.6	6.1	7.2	5.5	13.6	14.3	12.7
17	2.6	2.8	2.4	6.8	7.6	6.1	11.5	12.3	10.9
18	2.3	2.4	2.1	6.6	7.4	5.9	10.4	10.7	10.0
19	1.8	2.1	1.3	6.3	6.6	6.1	10.5	10.9	10.2
20	1.9	2.6	1.5	6.1	6.6	5.2	10.8	11.4	10.4
21	2.6	3.1	2.0	5.2	6.1	4.9	11.5	12.0	10.9
22	2.9	3.4	2.4	5.9	6.4	5.2	11.7	12.2	11.3
23	2.2	2.4	2.1	7.0	8.3	6.2	12.0	12.7	11.4
24	2.1	2.8	1.8	8.1	8.8	7.2	12.5	12.9	12.2
25	3.0	4.6	2.4	6.6	7.1	6.2	12.5	13.1	12.0
26	3.7	4.7	2.8	6.2	6.6	6.1	14.4	17.3	12.7
27	3.9	4.6	3.6	6.3	6.4	6.1	17.6	19.1	16.0
28	4.0	4.4	3.4	6.2	6.4	6.1	18.9	20.2	17.3
29	3.3	3.6	3.2	6.5	7.1	5.9	19.8	21.5	18.6
30	2.9	3.2	2.6	6.6	6.9	6.4	19.8	21.3	18.4
31	3.2	3.6	2.9				17.1	18.4	16.4